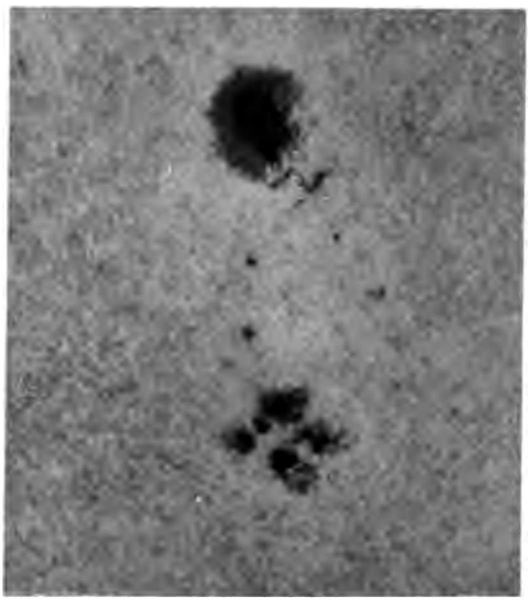

PHOTOGRAPH OF THE SOLAR SURFACE

Lick Observatory, October 19, 1896.
Sun's diameter about 44 inches.

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[See *Publications* A. S. P., Vol. VIII, p. 101.]

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The Examiner, San Francisco, California.
The Mercury, San José, California.
The Overland Monthly, San Francisco, California.
The Record-Union, Sacramento, California.
The Times, Los Angeles, California.
The Tribune, Oakland, California.

ON THE INFLUENCE OF CARBONIC ACID IN THE AIR UPON THE TEMPERATURE OF THE EARTH.

By Professor S. Arrhenius.

[Abstract by Edward S. Holden.]

[Note.—The following very brief and inadequate notice of an important paper presented to the Royal Swedish Academy of Sciences in December, 1895, and printed in the *Philosophical Magazine*, Volume XLI, pages 237-276, is given here chiefly for the purpose of directing attention to an entirely novel and simple explanation of the vexed questions relating to the Earth's temperature in past times and to the cause of the Glacial Epoch. It is impossible in the present place to give more than the shortest abstract.—E. S. H.]

I. Introduction: Observations of Langley *on Atmospheric Absorption.*

"A great deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall,* in particular, has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this: Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light-rays of the Sun, but retains the dark-rays from the ground. This idea was elaborated by Pouillet; and Langley was by some of his researches led to the view that "the temperature of the Earth under direct sunshine, even though our atmosphere were present, as now, would probably fall to −200° C., if that atmosphere did

* The author's references to the original authorities are, in general, omitted here.—E. S. H.

not possess the quality of selective absorption." This view, which was founded on too wide a use of NEWTON'S law of cooling, must be abandoned, as LANGLEY himself in a later memoir showed that the full Moon, which certainly does not possess any sensible heat-absorbing atmosphere, has a "mean effective temperature" of about 45° C.

The air retains heat (light or dark) in two different ways. On the one hand, the heat suffers a selective diffusion on its passage through the air; on the other hand, some of the atmospheric gases absorb considerable quantities of heat. These two actions are very different. The selective diffusion is extraordinarily great for the ultra-violet rays, and diminishes continuously with increasing wave-length of the light, so that it is insensible for the rays that form the chief part of the radiation from a body of the mean temperature of the Earth.

The selective absorption of the atmosphere is * * * of a wholly different kind. It is not exerted by the chief mass of the air, but in a high degree by aqueous vapor and carbonic acid, which are present in the air in small quantities. * * * The influence of this absorption is comparatively small on the heat from the Sun, but must be of great importance in the transmission of rays from the Earth. * * *

II. The Total Absorption by Atmospheres of Varying Composition.

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III. Thermal Equilibrium on the Surface and in the Atmosphere of the Earth.

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IV. Calculation of the Variation of Temperature that would ensue in consequence of a given variation of the Carbonic Acid in the Air.

If the quantity of carbonic acid increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetical progression. This rule — which naturally holds good only in the part investigated — will be useful for the following summary estimations.

V. Geological Consequences.

I should certainly not have undertaken these tedious calculations if an extraordinary interest had not been connected with

them. In the Physical Society of Stockholm there have been occasionally very lively discussions on the probable causes of the ice age; and these discussions have, in my opinion, led to the conclusion that there exists as yet no satisfactory hypothesis that could explain how the climatic conditions for an ice age could be realized in so short a time as that which has elapsed from the days of the glacial epoch. The common view hitherto has been that the Earth has cooled in the lapse of time; and if one did not know that the reverse has been the case, one would certainly assert that this cooling must go on continuously. Conversations with my friend and colleague, Professor HÖGBOM, together with the discussions above referred to, led me to make a preliminary estimate of the probable effect of a variation of the atmospheric carbonic acid on the temperature of the Earth. As this estimation led to the belief that one might in this way probably find an explanation for temperature variations of 5° – 10° C., I worked out the calculation more in detail, and lay it now before the public and the critics.

From geological researches the fact is well established that in tertiary times there existed a vegetation and an animal life in the temperate and arctic zones that must have been conditioned by a much higher temperature than the present in the same regions.* The temperature in the arctic zones appears to have exceeded the present temperature by about eight or nine degrees. To this genial time the ice age succeeded, and this was one or more times interrupted by interglacial periods with a climate of about the same character as the present, sometimes even milder. When the ice age had its greatest extent, the countries that now enjoy the highest civilization were covered with ice. This was the case with Ireland, Britain (except a small part in the south), Holland, Denmark, Sweden and Norway, Russia (to Kiev, Orel, and Nijni Novgorod), Germany and Austria (to the Harz, Erz-Gebirge, Dresden, and Cracow). At the same time an ice-cap from the Alps covered Switzerland, parts of France, Bavaria (south of the Danube), the Tyrol, Styria, and other Austrian countries, and descended into the northern part of Italy. Simultaneously, too, North America was covered with ice on the west coast to the forty-seventh parallel, on the east coast to the fortieth,

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* For details *cf.* NEUMAYR, *Erdgeschichte*, Bd. 2, Leipzig, 1887; and GEIKIE, "The Great Ice-Age," 3d ed., London, 1894. NATHORST, *Jordens Historia*, p. 989, Stockholm, 1894.

and in the central part to the thirty-seventh (confluence of the Mississippi and Ohio Rivers). In the most different parts of the world, too, we have found traces of a great ice age, as in the Caucasus, Asia Minor, Syria, the Himalayas, India, Thian Shan, Altai, Atlas, on Mount Kenia and Kilimandjaro (both very near to the equator), in South Africa, Australia, New Zealand, Kerguelen, Falkland Islands, Patagonia, and other parts of South America. The geologists in general are inclined to think that these glaciations were simultaneous on the whole Earth;* and this most natural view would probably have been generally accepted, if the theory of CROLL, which demands a genial age on the Southern hemisphere at the same time as an ice age on the Northern, and *vice versa*, had not influenced opinion. By measurements of the displacement of the snow-line we arrive at the result — and this is very concordant for different places — that the temperature at that time must have been 4°–5° C. lower than at present. The last glaciation must have taken place in rather recent times, geologically speaking; so that the human race certainly had appeared at that period. Certain American geologists hold the opinion that since the close of the ice age only some 7000 to 10,000 years have elapsed, but this most probably is greatly underestimated.

One may now ask, How much must the carbonic acid vary, according to our figures, in order that the temperature should attain the same values as in the tertiary and ice ages, respectively? A simple calculation shows that the temperature in the arctic regions would rise about 8° to 9° C., if the carbonic acid increased to 2.5 or 3 times its present value. In order to get the temperature of the ice age between the fortieth and fiftieth parallels, the carbonic acid in the air should sink to 0.62 – 0.55 of its present value (lowering of temperature 4° – 5° C.). The demands of the geologists, that at the genial epochs the climate should be more uniform than now, accords very well with our theory. The geographical annual and diurnal ranges of temperature would be partly smoothed away, if the quantity of carbonic acid was augmented. The reverse would be the case (at least to a latitude of fifty degrees from the equator), if the carbonic acid diminished in amount. But in both these cases, I incline to think that the secondary action due to the regress or the progress of the snow-covering would play the most important rôle. The theory

*NEUMAYR, *Erdgeschichte*, p. 648; NATHORST, *l. c.* p. 992.

demands also that, roughly speaking, the whole Earth should have undergone about the same variations of temperature; so that, according to it, genial or glacial epochs must have occurred simultaneously on the whole Earth. Because of the greater nebulosity [cloudiness] of the Southern hemisphere, the variations must there have been a little less (about fifteen per cent.) than in the Northern hemisphere. The ocean currents, too, must there, as at the present time, have effaced the differences in temperature at different latitudes to a greater extent than in the Northern hemisphere. This effect also results from the greater nebulosity in the arctic zones than in the neighborhood of the equator.

There is now an important question which should be answered, namely: — Is it probable that such great variations in the quantity of carbonic acid as our theory requires have occurred in relatively short geological times? The answer to this question is given by Professor HÖGBOM. As his memoir on this question may not be accessible to most readers of these pages, I have summed up and translated his utterances which are of most importance to our subject: *

"Although it is not possible to obtain exact quantitative expressions for the reactions in nature by which carbonic acid is developed or consumed, nevertheless there are some factors, of which one may get an approximately true estimate, and from which certain conclusions that throw light on the question may be drawn. In the first place, it seems to be of importance to compare the quantity of carbonic acid now present in the air with the quantities that are being transformed. If the former is insignificant in comparison with the latter, then the probability for variations is wholly other than in the opposite case.

"On the supposition that the mean quantity of carbonic acid in the air reaches 0.03 vol. per cent., this number represents 0.045 per cent. by weight, or 0.342 millim. partial pressure, or 0.466 gramme of carbonic acid for every $cm.^2$ of the Earth's surface. Reduced to carbon, this quantity would give a layer of about one millim. thickness over the Earth's surface. The quantity of carbon that is fixed in the living organic world can certainly not be estimated with the same degree of exactness; but it is evident that the numbers that might express this quantity ought to be of the same order of magnitude, so that the carbon

* HÖGBOM, *Svensk kemisk Tidskrift*, Bd. vi, p. 169 (1894).

in the air can neither be conceived of as very great, nor as very little, in comparison with the quantity of carbon occurring in organisms. With regard to the great rapidity with which the transformation in organic nature proceeds, the disposable quantity of carbonic acid is not so excessive that changes caused by climatological or other reasons in the velocity and value of that transformation might not be able to cause displacements of the equilibrium.

"The following calculation is also very instructive for the appreciation of the relation between the quantity of carbonic acid in the air and the quantities that are transformed. The world's present production of coal reaches, in round numbers, 500 millions of tons per annum, or one ton per km.^{2} of the Earth's surface. Transformed into carbonic acid, this quantity would correspond to about a thousandth part of the carbonic acid in the atmosphere. It represents a layer of limestone of 0.003 millim. thickness over the whole globe, or 1.5 km.^{3} in cubic measure. This quantity of carbonic acid, which is supplied to the atmosphere chiefly by modern industry, may be regarded as completely compensating the quantity of carbonic acid that is consumed in the formation of limestone (or other mineral carbonates) by the weathering or decomposition of silicates. From the determination of the amounts of dissolved substances, especially carbonates, in a number of rivers in different countries and climates, and of the quantity of water flowing in these rivers, and of their drainage-surface compared with the land-surface of the globe, it is estimated that the quantities of dissolved carbonates that are supplied to the ocean in the course of a year reach at most the bulk of 3 km.^{3} As it is also proved that the rivers the drainage regions of which consist of silicates convey very unimportant quantities of carbonates compared with those that flow through limestone regions, it is permissible to draw the conclusion, which is also strengthened by other reasons, that only an insignificant part of these 3 km.^{3} of carbonates is formed directly by decomposition of silicates. In other words, only an unimportant part of this quantity of carbonate of lime can be derived from the process of weathering in a year. Even though the number given were, on account of inexact or uncertain assumptions, erroneous to the extent of fifty per cent. or more, the comparison instituted is of very great interest, as it proves that the most important of all the processes by means of which carbonic acid has been removed

from the atmosphere in all times—namely, the chemical weathering of siliceous minerals,—is of the same order of magnitude as a process of contrary effect, which is caused by the industrial development of our time, and which must be conceived of as being of a temporary nature.

"In comparison with the quantity of carbonic acid which is fixed in limestone (and other carbonates), the carbonic acid of the air vanishes. With regard to the thickness of sedimentary formations and the great part of them that is formed by limestone and other carbonates, it seems not improbable that the total quantity of carbonates would cover the whole Earth's surface to a height of hundreds of metres. If we assume 100 metres—a number that may be inexact in a high degree, but probably is underestimated,—we find that about 25,000 times as much carbonic acid is fixed to lime in the sedimentary formations as exists free in the air. Every molecule of carbonic acid in this mass of limestone has, however, existed in and passed through the atmosphere in the course of time. Although we neglect all other factors which may have influenced the quantity of carbonic acid in the air, this number lends but very slight probability to the hypothesis, that this quantity should in former geological epochs have changed within limits which do not differ much from the present amount. As the process of weathering has consumed quantities of carbonic acid many thousand times greater than the amount now disposable in the air, and as this process from different geographical, climatological, and other causes has in all likelihood proceeded with very different intensity at different epochs, the probability of important variations in the quantity of carbonic acid seems to be very great, even if we take into account the compensating processes which, as we shall see in what follows, are called forth as soon as, for one reason or another, the production or consumption of carbonic acid tends to displace the equilibrium to any considerable degree. One often hears the opinion expressed, that the quantity of carbonic acid in the air ought to have been very much greater formerly than now, and that the diminution should arise from the circumstance that carbonic acid has been taken from the air and stored in the Earth's crust in the form of coal and carbonates. In many cases this hypothetical diminution is ascribed only to the formation of coal, whilst the much more important formation of carbonates is wholly overlooked. This whole method of reasoning on a continuous diminution of the

carbonic acid in the air loses all foundation in fact, notwithstanding that enormous quantities of carbonic acid, in the course of time, have been fixed in carbonates, if we consider more closely the processes by means of which carbonic acid has in all times been supplied to the atmosphere. From these we may well conclude that enormous variations have occurred, but not that the variation has always proceeded in the same direction.

"Carbonic acid is supplied to the atmosphere by the following processes: — (1) volcanic exhalations, and geological phenomena connected therewith; (2) combustion of carbonaceous meteorites in the higher regions of the atmosphere; (3) combustion and decay of organic bodies; (4) decomposition of carbonates; (5) liberation of carbonic acid mechanically inclosed in minerals on their fracture or decomposition. The carbonic acid of the air is consumed chiefly by the following processes: (6) formation of carbonates from silicates on weathering; and (7) the consumption of carbonic acid by vegetative processes. The ocean, too, plays an important rôle as a regulator of the quantity of carbonic acid in the air by means of the absorptive power of its water, which gives off carbonic acid as its temperature rises, and absorbs it as it cools. The processes named under (4) and (5) are of little significance, so that they may be omitted. So too the processes (3) and (7); for the circulation of matter in the organic world goes on so rapidly that their variations cannot have any sensible influence. From this we must except periods in which great quantities of organisms were stored up in sedimentary formations and, thus subtracted from the circulation, or in which such stored-up products were, as now, introduced anew into the circulation. The source of carbonic acid named in (2) is wholly incalculable.

"Thus the processes (1), (2), and (6) chiefly remain as balancing each other. As the enormous quantities of carbonic acid (representing a pressure of many atmospheres) that are now fixed in the limestone of the Earth's crust cannot be conceived to have existed in the air but as an insignificant fraction of the whole at any one time since organic life appeared on the globe, and since therefore the consumption through weathering and formation of carbonates must have been compensated by means of continuous supply, we must regard volcanic exhalations as the chief source of carbonic acid for the atmosphere.

"But this source has not flowed regularly and uniformly.

Just as single volcanoes have their periods of variation with alternating relative rest and intense activity, in the same manner the globe as a whole seems in certain geological epochs to have exhibited a more violent and general volcanic activity, whilst other epochs have been marked by a comparative quiescence of the volcanic forces. It seems therefore probable that the quantity of carbonic acid in the air has undergone nearly simultaneous variations, or at least that this factor has had an important influence.

"If we pass the above-mentioned processes for consuming and producing carbonic acid under review, we find that they evidently do not stand in such a relation to or dependence on one another that any probability exists for the permanence of an equilibrium of the carbonic acid in the atmosphere. An increase or decrease of the supply continued during geological periods must, although it may not be important, conduce to remarkable alterations of the quantity of carbonic acid in the air, and there is no conceivable hindrance to imagining that this might in a certain geological period have been several times greater, or, on the other hand, considerable less, than now."

As the question of the probability of quantitative variation of the carbonic acid in the atmosphere is in the most decided manner answered by Professor HÖGBOM, there remains only one other point to which I wish to draw attention in a few words, namely: Has no one hitherto proposed any acceptable explanation for the occurrence of genial and glacial periods? Fortunately, during the progress of the foregoing calculations, a memoir was published by the distinguished Italian meteorologist, L. DE MARCHI, which relieves me from answering the last question.* He examined in detail the different theories hitherto proposed — astronomical, physical, or geographical, and of these I here give a short *résumé*. These theories assert that the occurrence of genial or glacial epochs should depend on one or other change in the following circumstances:

(1) The temperature of the Earth's place in space.
(2) The Sun's radiation to the Earth (solar constant).
(3) The obliquity of the Earth's axis to the ecliptic.
(4) The position of the poles on the Earth's surface.

* LUIGI DE MARCHI: *Le Cause dell' Era Glaciale*, premialo dal R. Instituto Lombardo, Pavia, 1895.

(5) The form of the Earth's orbit, especially its eccentricity (CROLL).
(6) The shape and extension of continents and oceans.
(7) The covering of the Earth's surface (vegetation).
(8) The direction of the oceanic and aërial currents.
(9) The position of the equinoxes.

DE MARCHI arrives at the conclusion that all these hypotheses must be rejected. On the other hand, he is of the opinion that a change in the transparency of the atmosphere would possibly give the desired effect. According to his calculations, "a lowering of this transparency would effect a lowering of the temperature on the whole Earth, slight in the equatorial regions, and increasing with the latitude into the seventieth parallel; nearer the poles again a little less. Further, this lowering would. in non-tropical regions, be less on the continents than on the ocean, and would diminish the annual variations of the temperature. This diminution of the air's transparency ought chiefly to be attributed to a greater quantity of aqueous vapor in the air, which would cause not only a direct cooling, but also copious precipitation of water and snow on the continents. The origin of this greater quantity of water-vapor is not easy to explain." DE MARCHI has arrived at wholly other results than myself, because he has not sufficiently considered the important quality of selective absorption which is possessed by aqueous vapor. And further, he has forgotten that if aqueous vapor is supplied to the atmosphere, it will be condensed till the former condition is reached, if no other change has taken place. As we have seen, the mean relative humidity between the fortieth and sixtieth parallels on the Northern hemisphere is seventy-six per cent. If, then, the mean temperature sank from its actual value $+5.3$ by $4^\circ - 5^\circ$ C., *i. e.*, to $+1.3$ or $+0.3$, and the aqueous vapor remained in the air, the relative humidity would increase to 101 or 105 per cent. This is, of course, impossible; for the relative humidity cannot exceed 100 per cent. in the free air. *A fortiori*, it is impossible to assume that the absolute humidity could have been greater than now in the glacial epoch.

As the hypothesis of CROLL still seems to enjoy a certain favor with the English geologists, it may not be without interest to cite the utterance of DE MARCHI on this theory, which he, in accordance with its importance, has examined more in detail than the others. He says, and I entirely agree with him on this

point: "Now, I think I may conclude that from the point of view of climatology or meteorology, in the present state of these sciences, the hypothesis of CROLL seems to be wholly untenable, as well in its principles as in its consequences." *

It seems that the great advantage which CROLL'S hypothesis promised to geologists, viz: of giving them a natural chronology, predisposed them in favor of its acceptance. But this circumstance, which at first appeared advantageous, seems with the advance of investigation rather to militate against the theory, because it becomes more and more impossible to reconcile the chronology demanded by CROLL'S hypothesis with the facts of observation.

I trust that after what has been said the theory proposed in the foregoing pages will prove useful in explaining some points in geological climatology which have hitherto proved most difficult to interpret.

PLANETARY PHENOMENA FOR MARCH AND APRIL, 1897.

By PROFESSOR MALCOLM MCNEILL.

MARCH.

The Sun "crosses the line" and spring begins just after midnight, March 19-20 P. S. T.

Mercury is a morning star, having passed greatest west elongation on February 15th. At the beginning of the month it rises not quite an hour before sunrise, and may possibly be seen if the weather conditions are very favorable, but its distance from the Sun grows less throughout the month, and it comes to superior conjunction on April 1st.

Venus is an evening star, having passed its greatest east elongation in February. During the month it draws a little nearer the Sun, but sets more than three hours after sunset at the end of the month. On March 21st it comes to its maximum brilliancy, and all through the month it will be visible to the naked eye in full daylight, if the sky is clear and free from haze.

Mars is still a prominent object in the western sky in the evening, and does not set until after midnight. During the

* DE MARCHI, *l. c.* p. 166.

month it moves about fifteen degrees eastward from the constellation *Taurus* into *Gemini.* On March 1st it is about three degrees south of the second magnitude star *β Tauri.* The planet has lost very much in brightness, but is still conspicuous. At the end of the month its distance from us is about 130,000,000 miles, two and and one-half times as far away as it was at opposition in December.

Jupiter passed opposition on February 23d, and is above the horizon practically the whole night throughout March. It is retrograding, moving westward and northward about three degrees during the month toward the first magnitude star *Regulus* (*α Leonis*), and at the close of the month is about three degrees east of the star.

Saturn rises two hours earlier than during the corresponding period in February, and toward the close of the month is well above the horizon before midnight. It is in the constellation *Scorpio* and moves slowly eastward and then begins to move westward, but the total change of position is only a fraction of a degree. It is about one degree north of *β Scorpii.* The rings are in good position for observation, being well out toward their maximum opening.

Uranus is near *Saturn* about two degrees west and one degree thirty minutes south, and moves in about the same way but not as fast.

Neptune is in *Taurus* and sets at about midnight.

April.

Mercury passes superior conjunction on April 1st, and through the rest of the month is an evening star reaching greatest east elongation on the morning of April 28th. From the middle of the month it sets more than an hour after the Sun, and at the end of the month it sets nearly two hours later. This is the best time of the year for seeing the planet as an evening star.

Venus sets about three hours later than the Sun on April 1st; but it rapidly approaches the Sun and passes inferior conjunction on the morning of April 28th. It will not be easy to see after April 20th. *Venus* and *Mercury* are in conjunction on the morning of April 17th, *Mercury* being five degrees south.

Mars still sets after midnight. During the month it moves about seventeen degrees eastward in the constellation *Gemini,* and at the close is south of *Castor* and *Pollux* (*α* and *β Gemin-*

orum, the distance from the nearer star not being greatly different from their distance apart. The planet makes a very near approach to the third magnitude star ε *Geminorum* on the morning of April 8th. The least distance is only two minutes, and to the naked eye the star will be lost in the glare of the planet, but the phenomenon will occur while they are below our horizon.

Jupiter is above the horizon until long after midnight. It is in the constellation *Leo*, and moves slowly westward about one degree toward the first magnitude star *Regulus*, until it stops and begins to move eastward on April 26th. It is about two degrees east of *Regulus* at the end of the month.

Saturn rises at a little after 8 P.M. at the end of the month. It is in the constellation *Scorpio*, and moves about two degrees westward during April away from the second magnitude star β *Scorpii*, which is a little east and south of the planet.

Uranus is about two degrees west and the same amount south of *Saturn*. The distance west diminishes slightly, and the distance south increases slightly during the month.

Neptune is in the constellation *Taurus* and sets before midnight.

Occultations. The Moon occults the *Pleiades* group on the evening of April 5th. The Moon is then about four days old, and it will be a fine opportunity for seeing the disappearance of the stars at the dark limb. The times vary so for different parts of the country that it is not worth while to try to give any here.

EXPLANATION OF THE TABLES.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The [illegible] column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian the time given in the table must be corrected by [illegible] change per day, multiplied by [illegible] the longitude from Greenwich [illegible] This correction is [illegible] To find the standard time for the [illegible] by *adding* the difference [illegible] if the place is west of the [illegible] east. The same rules apply

to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

PHASES OF THE MOON, P. S. T.

		H. M.
New Moon,	Mar. 3,	3 56 A. M.
First Quarter,	Mar. 11,	7 28 A. M.
Full Moon,	Mar. 18,	1 28 P. M.
Last Quarter,	Mar. 25,	4 0 A. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Mar. 1.	22 51	− 7 22	6 37 A.M.	12 12 P.M.	5 47 P.M.
11.	23 27	− 3 29	6 21	12 10	5 59
21.	0 4	+ 0 27	6 6	12 7	6 8
31.	0 41	+ 4 22	5 49	12 4	6 19

MERCURY.

Mar. 1.	21 23	− 16 58	5 44 A.M.	10 45 A.M.	3 46 P.M.
11.	22 23	− 12 28	5 48	11 5	4 22
21.	23 27	− 5 53	5 50	11 30	5 10
31.	0 36	+ 2 33	5 51	11 59	6 9

VENUS.

Mar. 1.	1 36	+ 13 17	8 12 A.M.	2 58 P.M.	9 44 P.M.
11.	2 6	+ 17 16	7 48	2 48	9 48
21.	2 31	+ 20 27	7 21	2 34	9 47
31.	2 46	+ 22 37	6 48	2 9	9 30

MARS.

Mar. 1.	5 21	+ 25 39	11 7 A.M.	6 42 P.M.	2 17 A.M.
11.	5 39	+ 25 44	10 46	6 21	1 56
21.	5 59	+ 25 41	10 26	6 1	1 36
31.	6 20	+ 25 29	10 9	5 43	1 17

JUPITER.

Mar. 1.	10 27	+ 11 7	5 9 P.M.	11 47 P.M.	6 25 A.M.
11.	10 23	+ 11 34	4 23	11 3	5 43
21.	10 18	+ 11 58	3 38	10 19	5 0
31.	10 15	+ 12 16	2 55	9 37	4 19

SATURN.

Mar. 1.	15 56	− 18 12	12 23 A.M.	5 19 A.M.	10 15 P.M.
11.	15 56	− 18 11	11 43 P.M.	4 40	9 37
21.	15 56	− 18 8	11 3	4 0	8 57
31.	15 55	− 18 3	10 23	3 20	8 17

Uranus.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Mar. 1.	15 47	− 19 44	12 20 A.M.	5 10 A.M.	10 0 P.M.
11.	15 47	− 19 43	11 41	4 31	9 21
21.	15 47	− 19 42	11 2	3 52	8 42
31.	15 46	− 19 39	10 21	3 11	8 1

Neptune.

Mar. 1.	5 6	+ 21 29	11 10 A.M.	6 27 P.M.	1 44 A.M.
11.	5 6	+ 21 29	10 31	5 48	1 5
21.	5 7	+ 21 31	9 52	5 9	12 26
31.	5 8	+ 21 32	9 13	4 30	11 47 P.M.

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off right-hand limb as seen in an inverting telescope.)

		H. M.			H. M.
I, R,	Mar. 3.	3 0 A. M.	IV, R,	Mar. 14.	4 28 P. M.
I, R,	4.	9 30 P. M.	I, R,	19.	1 18 A. M.
III, R,	5.	6 27 P. M.	III, R,	20.	2 24 A. M.
I, R,	6.	3 58 P. M.	I, R,	20.	7 46 P. M.
II, R,	6.	11 25 P. M.	II, R,	21.	4 37 A. M.
I, R,	10.	4 55 A. M.	II, R,	24.	3 55 P. M.
I, R,	11.	11 23 P. M.	I, R,	26.	3 12 A. M.
III, R,	12.	10 25 P. M.	I, R,	27.	9 41 P. M.
I, R,	13.	5 52 P. M.	I, R,	29.	4 9 P. M.
II, R,	14.	2 1 A. M.	II, R,	31.	8 31 P. M.

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Mar. 2.	12 33 P. M.	Mar. 19.	5 27 P. M.
5.	9 22 A. M.	22.	2 16 P. M.
8.	6 11 A. M.	25.	11 5 A. M.
11.	3 0 A. M.	28.	7 54 A. M.
13.	11 49 P. M.	31.	4 43 A. M.
16.	8 38 P. M.		

Phases of the Moon, P. S. T.

		H. M.
New Moon,	Apr. 1,	8 24 P. M.
First Quarter,	Apr. 10,	12 27 A. M.
Full Moon,	Apr. 16,	10 25 P. M.
Last Quarter,	Apr. 23,	1 48 P. M.

The Sun.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Apr. 1.	0 44	+ 4 45	5 47 A.M.	12 3 P.M.	6 19 P.M.
11.	1 21	+ 8 31	5 32	12 1	6 30
21.	1 58	+ 12 3	5 18	11 59 A.M.	6 40
May 1.	2 36	+ 15 15	5 4	11 57	6 50

MERCURY.

97.	R. A. H. M.	Declination. ° '	Rises. H. M.	Transits. H. M.	Sets. H. M.
r. 1.	0 43	+ 3 28	5 52 A.M.	12 3 P.M.	6 14 P.M.
11.	1 59	+ 12 45	5 55	12 39	7 23
21.	3 8	+ 19 56	5 58	1 9	8 20
y 1.	3 55	+ 23 5	5 54	1 17	8 40

VENUS.

r. 1.	2 47	+ 22 45	6 44 A.M.	2 6 P.M.	9 28 P.M.
11.	2 48	+ 23 17	6 4	1 28	8 52
21.	2 34	+ 21 43	5 17	12 35	7 53
y 1.	2 12	+ 18 12	4 29	11 33 A.M.	6 37

MARS.

r. 1.	6 22	+ 25 28	10 7 A.M.	5 41 P.M.	1 15 A.M.
11.	6 44	+ 25 4	9 51	5 24	12 57
21.	7 7	+ 24 27	9 37	5 7	12 37
y 1.	7 30	+ 23 38	9 15	4 51	12 17

JUPITER.

r. 1.	10 15	+ 12 18	2 51 P.M.	9 33 P.M.	4 15 A.M.
11.	10 12	+ 12 30	2 8	8 51	3 34
21.	10 11	+ 12 35	1 28	8 11	2 54
ay 1.	10 11	+ 12 33	12 48	7 31	2 14

SATURN.

r. 1.	15 55	− 18 3	10 19 P.M.	3 16 A.M.	8 13 A.M.
11.	15 53	− 17 56	9 38	2 35	7 32
21.	15 51	− 17 48	8 55	1 53	6 51
ay 1.	15 48	− 17 39	8 13	1 11	6 9

URANUS.

r. 1.	15 46	− 19 39	10 16 P.M.	3 7 A.M.	7 58 A.M.
11.	15 45	− 19 35	9 35	2 26	7 17
21.	15 43	− 19 31	8 55	1 46	6 37
ay 1.	15 42	− 19 26	8 14	1 5	5 56

NEPTUNE.

r. 1.	5 8	+ 21 32	9 9 A.M.	4 26 P.M.	11 43 P.M.
11.	5 8	+ 21 34	8 31	3 48	11 5
21.	5 10	+ 21 36	7 53	3 10	10 27
y 1.	5 11	+ 21 37	7 15	2 32	9 49

ECLIPSES OF *JUPITER'S* SATELLITES, P. S. T.

(Off right-hand limb, as seen in an inverting telescope.)

			H. M.				H. M.
, R,	Apr.	3.	11 35 P. M.	I, R,	Apr.	19.	9 54 P. M.
, R,		5.	6 3 P. M.	I, R,		21.	4 22 P. M.
, R,		7.	11 6 P. M.	III, D,		24.	6 57 P. M.
, R,		11.	1 30 A. M.	III, R,		24.	10 17 P. M.
, R,		12.	7 59 P. M.	II, R,		25.	5 36 P. M.
, R,		15.	1 43 A. M.	I, R,		26.	11 48 P. M.
, R,		17.	6 19 P. M.	I, R,		28.	6 17 P. M.

MINIMA OF *ALGOL*, P. S. T.

	H.	M.		H.	M.
Apr. 3.	1	32 A. M.	Apr. 17.	9	37 A. M.
5.	10	21 P. M.	20.	6	26 A. M.
8.	7	10 P. M.	23.	3	15 A. M.
11.	3	59 P. M.	26.	12	4 A. M.
14.	12	49 P. M.	28.	8	53 P. M.

ABJURATIO GALILEI.

Ego, GALILEUS GALILEI, filius quondam VINCENTII GALILEI, Florentinus, aetatis meae Annorum 70, constitutus personaliter in judicio, & genuflexus coram vobis Eminentissimis, & Reverendissimis Dominis Cardinalibus universae Christianae Reipublicae contra haereticam pravitatem generalibus Inquisitoribus, habens ante oculos meos sacro sancta Evangelia, quae tango propriis manibus, juro me semper credidisse, & nunc credere, & Deo adjuvante in posterum crediturum omne id, quod tenet, praedicat, & docet S. Catholica, & Apostolica Romana Ecclesia. Sed quia ab hoc S. Officio, eo quod postquam mihi cum praecepto fuerat ab eodem juridice injunctum, ut omnino desererem falsam opinionem, quae tenet Solem esse centrum, nec moveri, nec possem tenere, defendere aut docere quovis modo, vel scripto praedictam falsam doctrinam: & postquam mihi notificatum fuerat praedictam doctrinam repugnantem esse Sacrae Scripturae; scripsi, & typis mandavi librum, in quo eandem doctrinam jam damnatam tracto, & adduco rationes cum magna efficacia in favorem ipsius, non afferendo ullam solutionem; idcirco judicatus sum vehementer suspectus de haeresi, videlicet, quod tenuerim, & crediderim Solem esse centrum Mundi, & immobilem, & terram non esse centrum, ac moveri.

Idcirco volens ego eximere a mentibus Eminentiarum Vestrarum, & cujuscunque Christiani Catholici vehementem hanc suspicionem adversum me jure conceptam, corde sincero, & fide non ficta abjuro, maledico, & detestor supradictos errores, & haereses, & generaliter quemcunque alium errorem, & sectam contrariam supradictae S. Ecclesiae, & juro me in posterum nunquam amplius dicturum, aut asserturum voce, aut scripto quidquam, propter quod possit haberi de me similis suspicio; sed si cognovero aliquem haereticum, aut suspectum de haeresi, denuntiaturum illum huic S. Officio, aut Inquisitori, & Ordinario loci, in quo fuero. Juro insuper ac promitto, me impleturum,

& observaturum integre omnes poenitentias, quae mihi impositae sunt, aut imponentur ab hoc S. Officio. Quod si contingat me aliquibus ex dictis meis promissionibus, protestationibus, & juramentis (quod Deus avertat) contraire, subjicio me omnibus poenis, ac suppliciis, quae a Sacris Canonibus, & aliis Constitutionibus generalibus, & particularibus contra hujusmodi delinquentes statuta, & promulgata fuerunt: Sic me Deus adjuvet, & Sancta ipsius Evangelia, quae tango propriis manibus.

Ego, GALILEUS GALILEI, supradictus abjuravi, juravi, promisi, & me obligavi ut supra, & in horum fidem mea propria manu subscripsi praesenti chirographo meae abjurationis, & recitavi de verbo ad verbum.

Romae in Conventu Minervae, hac die 22. Junii Anni 1633.

Ego, GALILEUS GALILEI, *abjuravi ut supra manu propria.*

THE WASHBURN OBSERVATORY.

By GEORGE C. COMSTOCK, DIRECTOR.

The University of Wisconsin owes to the late Governor C. C. WASHBURN the astronomical observatory which bears his name, but the original gift has been largely supplemented by both public and private munificence.

The observatory, as originally built in 1878, consisted of a dome, a centre hall, and two rooms, one east, the other west of the dome. To these were added, at the instance of the first Director, the late Professor J. C. WATSON, an east wing, connected to the original building by a corridor. The accompanying woodcut shows the building as seen from the east; the west room which contains the meridian-circle being entirely hidden. In the foreground to the right, is the Students' Observatory containing the six-inch CLARK equatorial, aperture 152mm, with which much of the early double-star work of Professor S. W. BURNHAM was done, and an admirable broken transit of 76mm aperture, by BAMBERG, which is the finest instrument of its type I have ever seen. In the extreme left of the cut is seen the roof of the Solar Observatory, constructed at his own expense by Professor WATSON, and destined for the reception of an underground telescope to be used in a search for intra-mercurial planets.

A thorough test of the capabilities of such a telescope having been made with disappointing results by Professor E. S. HOLDEN upon his accession to the directorship of the observatory, the building has long since been relegated to humbler uses.

The topography represented in the cut is in some respects misleading, although it very well shows the open character of the surroundings. The observatory stands upon the crest of a hill, which slopes gently to the west, and more rapidly to the south and north, upon which latter side it descends to the shores of Lake Mendota, about a hundred feet below it.

The principal instruments of the observatory are the CLARK equatorial telescope of 395_{mm} (sixteen inches) aperture, and the REPSOLD meridian-circle of 122_{mm} (five inches) aperture. The latter instrument is substantially similar in construction and appearance to the one illustrated at page 86, Vol. III, *Publications* of the Astronomical Society of the Pacific, and in the hands of the successive observers who have used it, has proved capable of furnishing results of the highest order of excellence, both in the determination of star places and in the investigation of stellar parallaxes.

In its optical parts the CLARK equatorial has shown itself an instrument of very superior quality, but in respect of mounting it lacks many of the conveniences of more recently constructed instruments. It is provided with a filar micrometer, double-image micrometer spectroscope, a ZOELLNER astro-photometer and a very complete set of oculars.

The small equatorial in the Students' Observatory, shown in the accompanying cut, has been provided with a modified LOEWY prism apparatus and employed in various researches requiring the simultaneous observation of stars situated in widely different parts of the heavens. This has required the construction of the peculiar type of dome there shown, with revolving semi-circular shutter. This shutter has proved in practice an excellent device, and may be recommended for general use in small domes.

Three astronomical clocks (employed in connection with the railway time-service), chronometers, a chronograph, an excellent universal instrument, and a considerable amount of subsidiary apparatus employed in instruction, supplement the equipment above described. To this there should be added the excellent Woodman Astronomical Library, comprising over five thousand

books and pamphlets, which are housed in the east wing of the observatory.

The scientific activity of the observatory has lain almost wholly along the lines of the older astronomy of precision, and the chief results of that activity are set forth in the ten volumes of its *Publications.*

MADISON, December, 1896.

SOME LUMINOUS APPEARANCES IN THE SKY.

BY W. H. S. MONCK.

In *Nature* for March 28, 1896, appeared an account of a luminous appearance seen in the sky by Dr. BRAUNER, of Prague, on the thirteenth of that month. There were five streaks reaching from the western horizon towards the zenith, apparently not of very long duration. It was only about an hour after sunset, and Dr. BRAUNER ascribed them to some peculiar reflection in the upper regions of the atmosphere. This explanation, however, is not applicable to a similar phenomenon described by Mr. LYON BROWNE, of Shrewsbury, in *Knowledge* for April; for it was seen at 8^h 30^m on the 4th of March, and therefore a considerable time after sunset. It disappeared in the course of ten minutes. It also stretched from the western horizon towards the zenith. Mr. BROWNE thought it might be the zodiacal light, but this seems hardly probable; and the descriptions given do not closely resemble the aurora.

The hypothesis of any peculiar reflection in the upper strata of the atmosphere is more clearly excluded by the following examples of similar phenomena seen in the east after sunset. Captain NOBLE describes one seen by him on the 28th of August, 1883, at 10^h 35^m P.M. "For a moment I thought I was tracing the apparition of a new and most glorious comet." It was seen in the east-northeast. His description appeared in *Knowledge*, and it seems that Mr. W. K. BRADGATE saw an appearance at Liverpool on the same night and in nearly the same direction that Captain NOBLE had seen it in Sussex, but the hour was so much later that it could hardly have been the same object. Then followed an account of a similar appearance seen by Mrs. HARBIN at

Yeovil at 8^h 30^m P.M. on the 21st of September, 1883, also in the east-northeast.

I saw a similar object myself on the 4th of September, 1885. It was in the east or east-northeast, and it was near 11 o'clock P.M. when I saw it. I took it for a very fine meteor-train, and described it as such in a letter to *The Observatory*. But I saw no meteor, and a comparison with the descriptions of Captain NOBLE, Mr. BRADGATE, and Mrs. HARBIN in *Knowledge* led me to conclude that what I had seen was of the same kind. As far as these scanty data go, these appearances seem to occur in spring and autumn, being in the west in spring and in the east in autumn. The resemblance to the tail of a comet presented by them has struck many observers, and I am inclined to think that on certain occasions they have been mistaken for comets' tails.

The first of these which I shall notice occurs in *The Annual Register* for 1761:

"July 18. At a quarter past eleven o'clock at night, a comet was seen off the quarter of His Majesty's ship Princess Royal at the Nore during nearly half a minute, very bright and light, but the clouds being thick obscured it presently. It had a very long tail and appeared to the E. S. E."

A real comet of this magnitude could not have escaped other observers. Clouds, however, seem rather a frequent accompaniment of the kind of phenomenon with which I am dealing.

On the 9th of April, 1894, Mr. EDWIN HOLMES announced that he had discovered a bright comet in the constellation *Draco*. Mr. HOLMES had discovered a comet not very long before, and the resemblance must have been striking in order to deceive him. Unfortunately, I have not the details of his observation at hand, but I have doubt that he mistook one of the appearances on which I have been commenting for a comet. The same remark applies to the discovery of a comet, or rather comet's tail, by Mr. EDDIE at Grahamstown, in South Africa, some time previously, but I do not recollect even the date of this announcement. The failures of astronomers are apt to be speedily forgotten. But clearly they saw something; and I believe both Mr. HOLMES and Mr. EDDIE saw it with the naked eye. That it was not the zodiacal light, or a meteor-train I am convinced; nor do I think that these appearances are explicable as auroras, though that solution seems, on the whole, more probable.

I have not hitherto seen any notice of this phenomenon on the

American continent, and I hope that American observers will keep an eye out for it in future. The great extent of the United States might enable it, if it be an atmospheric phenomenon, to be viewed simultaneously from all sides; while if it presented similar features at distant stations, light would also be thrown on its origin. Possibly, the present paper may lead to the publication of similar observations already made in America. The subject is, I think, worthy of the attention of astronomers. Even if the appearances should prove to be atmospheric, the atmosphere is the medium through which all observations must be made, and it is highly desirable on that account to become acquainted with all its properties. Its influence on the phenomena of lunar eclipses is of a very marked character, and has hardly received adequate consideration; while the twinklings of the stars is believed to be also an atmospheric phenomenon. It is probably owing to this twinkling — certainly to some property of the atmosphere — that stars are often caught by glimpses, and that astronomers have imagined that they saw stars were there were none. The satellites of *Uranus* and the stars in the trapezium of *Orion* form remarkable examples of this. If we could remove the atmosphere, our seeing would be steady.

But the occurrences in the upper portions of the atmosphere are worthy of study on their own account, and astronomers are the persons to study them. A pulsation or flickering, for instance, has often been observed in the tail of a comet. It has been pointed out that this can hardly be real; but if not so, it must indicate the passing of a wave of a peculiar character through the atmosphere. This wave seems to pass from the head of the comet to the end of the tail; and as the tail is pointed towards the Sun, the atmospheric wave must pass in the same direction. Twinkling is perhaps a similar phenomenon which exhibits itself among the stars successively rather than simultaneously — a star nearer to the Sun exhibiting any given phase later than a star more remote from it on the sphere. The condition of the upper strata of the atmosphere may also seriously affect our results in meteoric astronomy; for no meteor can be seen until it has traversed a sufficient quantity of air to change its original extreme cold into intense luminosity. But does such luminosity imply intense heat, or does the rush of the meteor excite some such properties in the air as those which render themselves visible in the aurora? We have a good deal still to

learn about our atmosphere, and it may afford a guide to us in dealing with the atmospheres of other bodies.

(TWENTY-SIXTH) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Mr. C. D. PERRINE, Assistant Astronomer in the Lick Observatory, for his discovery of an unexpected comet on November 2, 1896.

The Committee on the Comet-Medal,
EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. W. CAMPBELL.

1897, January 2.

ELEMENTS AND EPHEMERIS OF COMET *g*, 1896, (PERRINE).

By F. H. SEARES AND R. T. CRAWFORD.

From observations made at the Lick Observatory by Mr. C. D. PERRINE on December 8th, 9th, and 10th, we have computed the following elements and ephemeris of Comet *g*, 1896, (PERRINE). The observations were telegraphed to the Students' Observatory by Dr. HOLDEN:—

$$\begin{aligned} T &= 1896 \text{ Nov. } 24.7839 \text{ G. M. T.} \\ \left.\begin{aligned} \omega &= 163^\circ\ 38'\ 14'' \\ \Omega &= 243\ \ 41\ \ \ 6 \\ i &= 16\ \ 39\ \ 57 \end{aligned}\right\} &\ \text{Mean Equinox of 1896} \\ q &= 1.15349 \end{aligned}$$

Representation of middle place—

$$(O—C)\ \Delta\lambda \cos\beta = +5''.5 \qquad \Delta\beta = 0''.0$$

[The ephemeris at four-day intervals from December 13th to 25th is here omitted.] The brightness decreases from 0.91 (December 13th) to 0.59 (December 25th).

STUDENTS' OBSERVATORY,
Berkeley, December 12, 1896.

LIST OF EARTHQUAKES IN CALIFORNIA FOR THE YEAR 1896.

COMPILED BY C. D. PERRINE.

The following list is a continuation of similar reports printed in these *Publications:* Vol. II, p. 74; Vol. III, p. 247; Vol. V, p. 127; Vol. VI, p. 41; Vol. VII, p. 99, and Vol. VIII, p. 222. A more complete account will be published by the United States Geological Survey as a bulletin. The dates are civil dates. The times are Pacific Standard (120th meridian).

Roman numerals enclosed in parentheses indicate the intensity on the ROSSI-FOREL scale.

Some doubtful cases have been included, and are indicated by an interrogation point enclosed in parenthesis.

LIST OF EARTHQUAKE SHOCKS, 1896.

January 3. Esquimault (B. C.), 10:09 P. M. Reported by E. BAYNES REED, Esq. Victoria (B. C.), 10:20 P. M.; Port Angeles (Wash.), 10:30 P. M. The volcano of Kilauea in the Hawaiian Islands in eruption.

January 5. Volcanoes below the Cocopah Mountains reported in eruption.

January 8. Lake Chepala, Mexico.

January 25. Carson (Nevada), 4:45 A. M.; 4:46 A. M.; 5:02 A. M. Reported by Professor C. W. FRIEND.

January 27. Carson (Nevada), 7:59 A. M. (II); 8:34 A. M. (III); 11:04 A. M. (III); 11:19 A. M. (I); 1:01 P. M. (IV); 6:32 P. M. (II), and quite a number of light tremors between. Reported by Professor C. W. FRIEND.

February 5. Tauquiz Mountain (near San Jacinto). Volcanic eruption. (?)

February 6. East Clallam (Wash.), 9:55 P. M.

February 13. Redding, 10± A. M.; Weaverville, 9:55 A. M.; Eureka, 9:55 A. M.

February 15. Los Angeles, 2:52 P. M. (another report says 2:45 P. M.); Pasadena, 2:57 P. M.

March 15. Burrard Mountains (ten miles from Vancouver, (B. C.). Volcanic eruption. (?)

April 2. Portland (Oregon), 3:20± A. M.; McMinnville (Oregon), 3:17 A. M.

April 28. San Francisco, 2:57 P. M.; Alameda.
June 20±. Tidal wave on the Mendocino coast.
July 3. San Diego, 9:27 P. M.
July 23. Vallejo, 1:50 A. M.
August 11. Mt. Hamilton, 8:58:7 ± P. M. (II). E. S. H.; Alameda.
August 17. Merced, 3:40 A. M.; Visalia, 3:29, or 3:30 A. M. (another report says 3:26 A. M.).
August 18. Mt. Hamilton, 11:0:24 ± P. M. (III). E. S. H.; 11:0:13 P. M. A. L. C.; Napa, P. M.; Evergreen, 11:0:15 P. M. Reported by WM. WEHNER, Esq.
August 19. Alameda.
August 26. Mount Hood (Oregon). An avalanche. (Due to an earthquake (?).
September 1. Pinole, Contra Costa County, California. Powder Works exploded at 1 P. M.
September 10. Santa Rosa, 3:45 A. M.
September 24. 5^h 25^m 30^s ± P. M. (III), E. S. H.
5^h 25^m 45^s P. M. (I), C. D. P.)
October 19. Santa Rosa, 6 ± A. M.
November 3. Mt. Hamilton, 10:58.44 ± 1^s A. M., W. W. C.
November 11. Cahto, 2 A. M.
November 29. Mt. Hamilton, 11:3:37 A. M. (I). C. D. P.
December 8. Mexico (Pacific ports), 9:30 A. M., 1:30 P. M. and 5 P. M.
December 17. Santa Barbara. At 8 A. M. a tidal wave destroyed a large section of the boulevard.
December 22. Mt. Hamilton, 1^h 52^m 42^s P. M., P. S. T.

(TWENTY-SEVENTH) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Mr. C. D. PERRINE, Assistant Astronomer in the Lick Observatory, for his discovery of an unexpected comet on December 8, 1896.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. W. CAMPBELL.

1897, February 8.

NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

PHOTOGRAPH OF THE SOLAR SURFACE MADE AT THE LICK OBSERVATORY.

[See the Frontispiece.]

The frontispiece of the present volume is a gelatine print of a portion of the solar surface copied by Mr. A. L. COLTON from a negative made by himself and Mr. C. D. PERRINE, with the thirty-six-inch equatorial, on October 19, 1896, at $10^h\ 21^m\ 2^s$ A.M. The aperture of the great telescope was reduced to eight inches, and the exposure was made by means of a quick-shutter presented to the Lick Observatory by Dr. A. BLAIR THAW, of Santa Barbara. Dr. THAW bears the expense of making the plate for this number of the *Publications*, and deserves and will receive the thanks of the Society. EDWARD S. HOLDEN.

DISCOVERY OF COMET *g*, 1896, (PERRINE).

This comet was discovered on the evening of December 8th, at about 11:30 o'clock, in the constellation *Pisces*. At $20^h\ 29^m\ 48^s$ G. M. T. its position was R. A. $0^h\ 52^m\ 26^s.70$, Decl. $+6^\circ\ 24'\ 51''.9$. It was moving rapidly east and more slowly south.

The comet was moderately bright,—about as bright as a star of eighth magnitude,—and in the four-inch comet-seeker appeared round, with a well-defined central condensation. In the twelve-inch equatorial, the comet was about $5'$ in diameter, and showed a stellar nucleus. The nebulosity surrounding the head did not appear to be symmetrical, but was more sharply defined on the south following side, while it was extended on the north preceding side in the shape of a broad fan. This fan-like extension was not traceable for any considerable distance. On subsequent

* Lick Astronomical Department of the University of California.

nights the air has been full of haze, generally, so that I have not been able to see the fainter nebulosity about the head.

Observations were secured on the 9th and 10th also,—on the latter date with difficulty, owing to thick haze; and from these and the one of the 8th Professor HUSSEY and I deduce the following system of parabolic elements:—

$$\begin{aligned} T &= \text{November } 25.6659 \\ \omega &= 164^\circ\ 36'\ \ 5'' \\ \Omega &= 243\ \ 48\ \ 40 \\ i &= \ \ 16\ \ 26\ \ 29 \\ \log q &= 0.06220 \end{aligned} \qquad \left.\begin{matrix} \\ \\ \end{matrix}\right\} 1896.0$$

Residuals for the middle place (O—C)—

$$\Delta\lambda' \cos\beta' \quad -1''$$
$$\Delta\beta' \quad +3$$

An ephemeris from these elements shows the comet to be rapidly receding from both the Earth and Sun, and consequently growing fainter. C. D. PERRINE.

MT. HAMILTON, December 14, 1896.

ASTRONOMISCHE GESELLSCHAFT ZONE $-9^\circ\ 50'$ to $-14^\circ\ 10'$.

This zone was observed with the meridian-circle of Harvard College Observatory during the years 1888–1892. The observations have since been reduced, and the apparent place resulting from each observation can now be furnished. In most cases, the mean place has also been computed. The work of revision by additional observations of stars, accidentally omitted or unsatisfactorily observed, is now in progress, and will probably be completed during the year 1897. ARTHUR SEARLE.

RELIEF-MAP OF THE LICK OBSERVATORY RESERVATION (2600 ACRES).

By the kindness of Mr. HENRY GANNETT, Chief of the Topographical Bureau of the U. S. Geological Survey, a survey was made of the region about Mt. Hamilton during the summer of 1895. A map on the scale of $\frac{1}{45000}$, with contours at intervals of fifty feet has been prepared. In order to exhibit the data in a more vivid way, Mr. GEORGE A. MERRILL, Principal of the California School of Mechanic Arts (the trade-school founded by Mr. LICK in San Francisco), has kindly undertaken to pre-

pare a relief-model of the reservation on a scale of 500 feet to the inch. This model will be made by the pupils of the Lick School. When it is finished copies will be deposited at Berkeley, Mt. Hamilton, and San Francisco. In making plans for the establishment of a State Forestry Station on the reservation, for improvement of the water-supply, for the fencing of the land, for new roads, etc., etc., this model will be of much use. If the reservation is ever taken by the State as a Park (which is greatly to be hoped), such a model will be indispensable. The thanks of the Observatory are returned to Messrs. GANNETT and MERRILL for their valued co-operation in our plans.

EDWARD S. HOLDEN.

January 1, 1897.

METEORS (NOVEMBER 15, 1896.)

Mrs. F. K. UPHAM, National Soldiers' Home, Los Angeles County, a member of the Society, reports having counted nineteen meteors between four and five o'clock on the morning of November 15, 1896, the greater number of which descended from northwest of the zenith. Two of these were very brilliant, but none were visible for more than thirty degrees of their path.

On August 25, 1896, at 7:47 o'clock, an unusually brilliant meteor was seen near the eastern horizon, from whence it passed over the zenith, disappearing five degrees to the west. Its motion was very slow, and it left a bright train.

OBSERVATION OF THE *LEONID* METEORS.

Mr. WILLIAM YATES, a member of the Astronomical Section of the Southern California Academy of Sciences, observed the *Leonids* on the morning of November 14, 1896, from his residence in Los Angeles. From 4 to 5:30 A. M. he counted seventeen meteors, of which all but one were true *Leonids*. One of the latter left a train, which remained visible between four and five minutes.

NOTICE TO MEMBERS OF THE SOCIETY.

The Lick Observatory publishes for distribution "A Brief Account of the Lick Observatory of the University of California," 8vo, (1895), 29 pages and 15 plates. A copy will be sent to any member of the Society who signifies his desires to have it.

EDWARD S. HOLDEN.

MT. HAMILTON, January, 1897.

THE GREAT SUN-SPOT OF JANUARY, 1897.

On photographing the Sun with the forty-foot photoheliograph, January 5th, after two or three days of cloudy weather, I found an unusually large spot well-started on its journey across the disc. It could have been seen a day or two previously with suitable weather, and had undoubtedly been seen elsewhere. Occurring near a time of spot-minimum, it was of all the greater interest. I was enabled to photograph it every day from the 5th to the 11th inclusive, and on the 14th and 15th; on the latter date just as it was disappearing at the western limb. The "seeing" on January 5th was so bad that the photographs taken were very poor; those secured on the following days were much better. Figure 1 shows one of the photographs obtained on the 6th, and Figure 2 one obtained on the 8th, the spot having meanwhile changed considerably in form. The small, isolated companion-spot retained its shape with curious persistence. The extreme length of the nucleus of the principal spot is about 35,000 miles; the length over all of the great spot and its long attendant train of bits of penumbral matter, about 130,000 miles. The first, second, third, and fifth figures are enlarged three diameters from photoheliograph negatives, and have a scale of approximately 64,000 miles to the inch.

January 14th, the spot presented a most interesting appearance as it approached the western limb. Figures 3 and 4 are from negatives taken on that date. Extending easterly from the spot is a fine cluster of faculæ.

Figure 4 is a full-size reproduction of a negative by Mr. PERRINE and myself, using the photographic correcting-lens of the thirty-six-inch equatorial, a rapid shutter made especially for this work and presented to the observatory by Dr. A. B. THAW, and a supplementary lens for enlarging directly, giving a scale about eight times as large as that of the focal image. The negative from which this picture was made, is one of the best results yet obtained with this instrumental outfit. Unluckily the air was very unsteady, as is shown by the edge of the Sun and the different portions of the spot.

Figure 5 was photographed on the morning of January 15th, as the spot was on the very edge of the Sun's disc. In the original negative a faint trace of the nucleus can be seen in the midst of the penumbra. The appearance of indentation is inter-

Fig. 1.

Fig. 2.

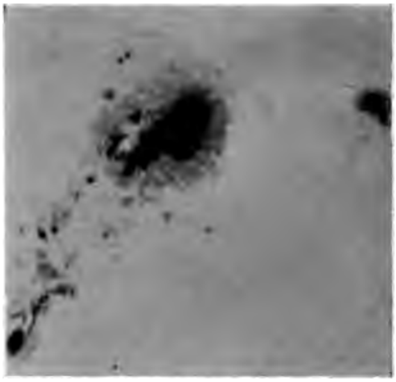
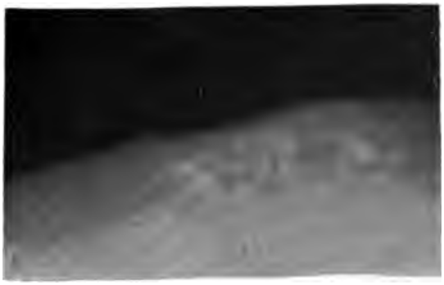


Fig. 3.

Fig. 4.

Fig. 5.



THE GREAT SUN-SPOT OF JANUARY, 1897.

esting, though it must not be ascribed to the actual depression of the spot, but rather to its deficiency in light compared to the Sun's surface. In this case, also, "bad seeing" somewhat interfered with the best results.

Owing to the great size of the spot, it will probably last for more than a revolution of the Sun, and its reappearance at the eastern limb near the end of this month will be awaited with much interest. A. L. COLTON.

January 20, 1897.

THE GREAT SUN-SPOT OF JANUARY, 1897.

On Friday, January 15th, the large sun-spot, first noticed by Mr. COLTON, was passing out of view over the west limb of the Sun, and it was hoped that a favorable opportunity would thus be presented for determining the relative elevation of umbra and faculæ with respect to the photosphere. I, therefore, watched the spot with the twelve-inch equatorial, diaphragmed down to four inches aperture, using a HERSCHEL prism and a 150-power eye-piece—the highest power the seeing would permit.

At times the principal umbra appeared distinctly depressed, and the faculæ at all times seemed elevated above the average surface level; but the seeing was at no time good enough to make it certain that this was not merely the effect of irradiation. The spot was under observation from $10^h\ 50^m$ A. M. to $2^h\ 30^m$ P. M.

R. G. AITKEN.

January 19, 1897.

THE HELIOCENTRIC THEORY AND THE UNIVERSITY OF CAMBRIDGE IN 1669.*

"After dinner his highness (Grand Duke COSMO III of Florence) desirous to gratify the Vice-Chancellor (of the University of Cambridge), who entreated him to honor the academy with his presence, went thither with his attendants, followed by the Vice-Chancellor and the heads of the University. In the principal hall, into which his highness was introduced, a short Latin oration was made by one of the Professors, which, being pronounced in the same manner as that which was spoken in the morning, was but little understood. And afterward his highness was

*One hundred and twenty-six years after the death of COPERNICUS.

present at different questions which were propounded for disputation and strenuously opposed by Professors and Masters of Arts. De methodo philosophandi in experimentis fundata, et *Contra Systema Copernicanum.*"—From Travels of COSMO the Third, Grand Duke of Tuscany, through England, during the reign of King CHARLES the Second (1669), (translated from the Italian manuscript by Count MAGALOTTI in the Laurentian library at Florence. London, 1821, pp. 224, 225.)

HONOR CONFERRED ON PROFESSOR BARNARD.

The Royal Astronomical Society of London has awarded its gold medal of the present year to Professor BARNARD for his astronomical discoveries and observations.

PRICES OF REFLECTING TELESCOPES.

From an article in the *Strand Magazine* for October, 1896 (an interview with Sir HOWARD GRUBB, F. R. S.), it appears that the original cost of Lord ROSSE's six-foot reflector was about £12,000, of the four-foot Melbourne reflector about £4600, and that the estimated cost of a ten-foot reflector of eighty feet focus is £33,000.

A BRILLIANT METEOR.

[Extract from a private letter by WM. S. MOSES.]

"This evening (December 31, 1896) at 6^h 7^m P. S. T., I observed a brilliant meteor. It appeared at ϵ *Tauri* and traveled in a southwest course, expiring at ι *Ceti*. It moved very slowly, being visible, I think, three seconds. Its train was dazzling white and cast a distinct shadow of the trees which intercepted its light. The upper and lower edges of the train were bluish in color. The head was scintillating. It did not burst, nor did I hear an explosion. I happened to be looking at *Mars* and saw it from beginning to end. It did not appear to be far distant. As I took my chart and plotted its course within three minutes after it disappeared, I think I am reasonably correct. It was the finest meteor I ever saw. Accompanying I give a sketch of it."*

LONE MOUNTAIN OBSERVATORY,
San Francisco, Cal.

* The sketch is here omitted.

LIST OF AMERICAN FOREIGN ASSOCIATES OF THE ROYAL ASTRONOMICAL SOCIETY.

The first American who was elected one of the fifty Foreign Associates of the Royal Astronomical Society (founded in 1820) was WILLIAM CRANCH BOND, who was chosen in 1849. Following is a complete list:

1849.	WILLIAM C. BOND.	1872.	LEWIS M. RUTHERFURD.
1850.	BENJAMIN PEIRCE.	—	CHARLES A. YOUNG.
—	ALEX. D. BACHE.	1876.	GEORGE W. HILL.
—	O. M. MITCHEL.	1879.	ASAPH HALL.
—	SEARS C. WALKER.	—	C. H. F. PETERS.
1855.	F. F. E. BRUENNOW.	1881.	EDWARD C. PICKERING.
—	MATTHEW F. MAURY.	1883.	SAMUEL P. LANGLEY.
—	BENJAMIN A. GOULD.	1884.	EDWARD S. HOLDEN.
1863.	GEORGE P. BOND.	1889.	SETH C. CHANDLER.
1866.	TRUMAN H. SAFFORD.	1890.	LEWIS BOSS.
1872.	SIMON NEWCOMB.	1892.	WILLIAM L. ELKIN.
—	HUBERT A. NEWTON.	1894.	ALBERT A. MICHELSON.

LIST OF AMERICANS WHO HAVE RECEIVED THE MEDAL OF THE ROYAL ASTRONOMICAL SOCIETY.

Since the year 1823, the Royal Astronomical Society has given a gold medal for services to science. The first American to receive this medal was GEORGE PHILLIPS BOND. The medal has been awarded to the following Americans:

1865.	GEORGE P. BOND.	1887.	GEORGE W. HILL.
1874.	SIMON NEWCOMB.	1894.	SHERBURNE W. BURNHAM.
1879.	ASAPH HALL.	1896.	SETH C. CHANDLER.
1883.	BENJAMIN A. GOULD.	1897.	EDWARD E. BARNARD.
1886.	EDWARD C. PICKERING.		

EARTHQUAKE AT OAKLAND, JANUARY 17, 1897.

On January 17, 1897, at $1^h\ 11^m\ 11^s$ P. M., P. S. T., two sharp shocks were observed, about one second apart. The time given is for the second shock, and is believed to be correct within a second. In half an hour my watch was compared with W. U. time, and the correction applied to the observed time.

The first shock seemed heavier than the second, and both suggested an explosion rather than an earthquake. An examination of the country in the direction of the powder mills was made immediately from the house-top with a glass, but no smoke or

other evidences of an explosion were visible. A heavy rumbling was noticed just preceding the shocks, and the house creaked. The windows on the north side of the house seemed to rattle before and louder than those on the opposite side. The chandelier shook, and as it came to rest the vibrations appeared to be north and south, approximately. A. H. BABCOCK.

OAKLAND, Cal., January 17, 1897.

ELLIPTIC ELEMENTS OF COMET *g*, 1896, (PERRINE), BY W. J. HUSSEY AND C. D. PERRINE.

From Mount Hamilton observations of December 8th, December 20th, and January 5th, we have computed the following elements of this comet:

Epoch, 1896, December 8.5, Gr. M. T.

$$\begin{aligned} M &= 2^\circ\ 3'\ 9''.5 \\ \Omega &= 246\ 30\ 22.1 \\ \omega &= 163\ 51\ 41.5 \\ \pi &= 50\ 22\ 3.6 \\ i &= 13\ 45\ 19.7 \end{aligned} \left.\vphantom{\begin{aligned} a\\b\\c\\d \end{aligned}}\right\} \text{Mean Ecliptic, 1897.0}$$

$$\begin{aligned} \log \epsilon &= 9.836649 \\ \log a &= 0.549565 \\ \log \mu &= 2.725660 \\ \text{Period} &= 6.67 \text{ years.} \end{aligned}$$

With the exception of ω or π, these elements closely resemble those of BIELA'S Comet at its last apparition in 1852.

MOUNT HAMILTON, January 14, 1897.

OBSERVATIONS OF THE COMPANION TO *PROCYON*, AND OF THE COMPANION TO *SIRIUS*, BY J. M. SCHAEBERLE.

Measures of the Companion to Procyon.

			°	″	
1896.	November	13.	$p = 318.8$	$s = 4.58$	wt. = 3
	November	14.	320.4	4.58	2
	December	19.	319.3	4.89	1
1897.	January	10.	322.3	4.62	3

Measures of the Companion to Sirius.

1896.	October	28.	188.3	3.65	1
	October	30.	190.0	3.65	3
	November	6.	188.3	3.85	3
1897.	January	10.	189.4	3.72	5

Honor Conferred on Dr. Lewis Swift.

A press-telegram of January 5th notifies that the medal founded by Mrs. HANNAH JACKSON (*née* GWILT) has been conferred by the Royal Astronomical Society on Dr. SWIFT, Director of the Lowe Observatory, "in recognition of his services to the cause of science in the discovery of comets, etc."

The Ladd Observatory (Providence, R. I.)

During the year's leave of absence of the Director of the Ladd Observatory (Professor UPTON), which is to be spent at the Arequipa station of the Harvard College Observatory, his place is to be filled by Mr. F. W. VERY, who has resigned the position at the Allegheny Observatory which he has occupied for so many years.

Measures of the Companion to *Procyon*.

I have secured three measures with the thirty-six-inch refractor of the companion to *Procyon* discovered by Professor SCHAEBERLE. The mean is:

1896.98 $321^\circ.0$ $4''.84$

R. G. AITKEN.

January 19, 1897.

Erratum in *Publications* A. S. P., No. 53.

Volume VIII, No. 53, page 311, line 9, *for* SCHIAPARELLI *read* SCHAEBERLE. C. A. Y.

Astronomical Telegrams. (*Translation.*)

Lick Observatory, Dec. 9, 1896.

To Harvard College Observatory and Students' Observatory: (Sent 10 A. M.)

A comet was discovered by PERRINE, December 8, $20^h\ 29^m\ 48^s$ G. M. T.; R. A. $0^h\ 52^m\ 26^s.7$, Decl. $+ 6^\circ\ 24'\ 52''$. Daily motion R. A. $+ 7^m$, Decl. $- 30'$. It is about as bright as a star of eighth magnitude; has a well-defined nucleus and tail.

Lick Observatory, Dec. 9, 1896.

To Harvard College Observatory and Students' Observatory: (Sent 10:45 P.M.)

Comet PERRINE was observed by PERRINE, December 9, $15^h\ 37^m\ 50^s$ G. M. T.; R. A. $0^h\ 58^m\ 9^s.9$, Decl. $+ 6^\circ\ 4'\ 30''$.

Lick Observatory, December 10, 1896.

To Harvard College Observatory and Students' Observatory: (Sent 8:48 P.M.)

Comet PERRINE was observed by PERRINE, December 10^d $14^h\ 8^m\ 58^s$ G. M. T.; R. A. $1^h\ 4^m\ 51^s.9$, Decl. $+\ 5^\circ\ 40'\ 46''$.

Lick Observatory, December 11, 1896.

To Harvard College Observatory: (Sent 10 A.M.)

Elements and ephemeris of Comet *g* were computed by HUSSEY and PERRINE. $T =$ Nov. 25.67, $\omega = 164^\circ\ 36'$, $\Omega = 243^\circ\ 49'$, $i = 16^\circ\ 26'$, $q = 1.1540$.

(Ephemeris is omitted here.)

ASTRONOMICAL TELEGRAMS.

(Dated) BOSTON, Jan. 11, 1897.

To Lick Observatory: (Received Jan. 11, $7^h\ 30^m$ P. M.)

LOWELL announces rift in Martian north polar cap since January 7. Longitude, forty degrees.

JOHN RITCHIE, Jr.

TELEGRAM.

(Dated) Lick Observatory, Jan. 15, 1897.

To Harvard College Observatory: (Sent $10^h\ 0^m$ A. M.)

HUSSEY and PERRINE find Comet *g* periodic. Period and elements, except *omega*, which differs sixty degrees, closely resemble BIELA.

TELEGRAM *(Translation)*.

(Dated) CAMBRIDGE, MASS., Jan. 15, 1897.

To E. S. HOLDEN: (Received Jan. 15, 1897, 3:55 P. M.)

Please telegraph best elements and ephemeris available of Comet *g*. *Journal* issue awaiting them.

SETH C. CHANDLER.

The information requested above was supplied in a telegram sent 8:50 P. M., January 15, 1897.

(See elements on another page, the ephemeris being omitted.)

MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS, HELD IN THE ROOMS OF THE SOCIETY, JANUARY 30, 1897, AT 7:30 P. M.

President HUSSEY presided. A quorum was present. The minutes of the last meeting were approved. The following members were duly elected:

LIST OF MEMBERS ELECTED JANUARY 30, 1897.

Mr. FREDERICK E. BRASCH	1814½ Devisadero St., S. F., Cal.
Mr. J. W. ERWIN	2647 Durant Avenue, Berkeley, Cal.
Mr. ALBERT EDWARD GRAY	Lasata, Oroville, Butte Co., Cal.
Mr. EDWARD G. LUKENS	200 Market St., S. F., Cal.
Mr. ALEXANDER W. ROBERTS	14 Lindsay Place, Leith, Scotland.
Dr. HORACE H. TAYLOR	Los Angeles, Cal.
Mrs. COLUMBUS WATERHOUSE	2213 Howard St., S. F., Cal.

The following resolutions were, on motion, adopted:

Resolved, That the Directors of the Astronomical Society of the Pacific return the thanks of the Society to Dr. A. BLAIR THAW for his acceptable gift of the frontispiece to Volume IX of the *Publications*.

WHEREAS, There are at Mt. Hamilton, in the custody of the Secretary, and belonging to the Society, sundry articles of bedding, etc., which, not being used, are deteriorating with age; be it therefore

Resolved, That the Secretary at Mt. Hamilton is hereby authorized to dispose of the said articles for the benefit of the Society.

WHEREAS, The Society possesses a considerable number of valuable books and periodicals that are still unbound; and

WHEREAS, A considerable portion of the income from the ALEXANDER MONTGOMERY Library Fund remains unexpended; be it therefore

Resolved, That the unexpended portion of the accrued interest from this Fund be expended—

(1) For bindings for valuable unbound books and periodicals already in the possession of the Society; and then, if any portion of this income remains unexpended,

(2) For the purchase of additional astronomical books and periodicals; and be it further

Resolved, That the President and Library Committee be authorized to carry these provisions into effect.

Adjourned.

MINUTES OF THE MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, HELD IN THE LECTURE HALL OF THE CALIFORNIA ACADEMY OF SCIENCES, JANUARY 30, 1897.

The meeting was called to order by President HUSSEY. The minutes of the last meeting were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

A committee to nominate a list of eleven Directors and Committee on Publication, to be voted for at the annual meeting, to be held on March 27th, was appointed, as follows: Messrs. ARTHUR RODGERS (Chairman), JOHN DOLBEER, A. CALLANDREAU, GEO. W. PERCY, and W. H. HAMMON.

A committee to audit the accounts of the Treasurer, and to report at the annual meeting, was appointed, as follows: Messrs. VON GELDERN (Chairman), MCCONNELL, and JAMES R. KELLY.

The following papers were presented:

1. Recent developments in Astronomical Photography, illustrated by lantern slides, by Mr. CHAS. B. HILL.
2. Some notes on the next Total Solar Eclipse, with lantern-slide illustrations, by Mr. CHAS. BURCKHALTER.
3. Planetary Phenomena for March and April, 1897, by Professor M. MCNEILL, of Lake Forest.
4. List of Earthquakes in California, 1896, by Mr. C. D. PERRINE, of Mount Hamilton.
5. Some Luminous Appearances in the Sky, by Mr. W. H. S. MONCK, of Dublin.

Mr. HILL read a paper on the recent developments in Astronomical Photography, illustrated by sixty lantern slides made at the Lick Observatory and elsewhere; the photographs exhibited were so selected as to illustrate the results obtained up to the present time in all the different branches of celestial photography.

Mr. BURCKHALTER showed a map of the path of the next total solar eclipse in India, and gave some general information as to the route and cost of travel to India, and the probable condition of the weather at the time of the eclipse.

Adjourned.

OFFICERS OF THE SOCIETY.

W. J. HUSSEY (Lick Observatory), ... *President*
E. J. MOLERA (606 Clay Street, S. F.) . . . . } *Vice-Presidents*
E. S. HOLDEN (Lick Observatory), ... }
O. VON GELDERN (819 Market Street, S. F.) . . . . . . }
C. D. PERRINE (Lick Observatory), ... *Secretary*
F. R. ZIEL (410 California Street, S. F.), ... *Secretary and Treasurer*

Board of Directors—Messrs. EDWARDS, HOLDEN, HUSSEY, MOLERA, Miss O'HALLORAN, Messrs. PARDEE, PERRINE, PIERSON, STRINGHAM, VON GELDERN, ZIEL.

Finance Committee—Messrs. VON GELDERN, PIERSON, STRINGHAM.

Committee on Publication—Messrs. HOLDEN, BABCOCK, AITKEN.

Library Committee—Miss O'HALLORAN, Messrs. MOLERA, BURCKHALTER.

Committee on the Comet-Medal—Messrs. HOLDEN (*ex-officio*), SCHAEBERLE, CAMPBELL.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. RUTHVEN W. PIKE.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. CAMILO GONZALEZ, FRANCISCO RODRIGUEZ REY.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

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ASTRONOMY AND ASTRONOMERS IN THEIR RELATIONS TO THE PUBLIC.

By W. J. HUSSEY.

At this meeting of this Society, it is the custom for the retiring President to address you on some scientific subject, and it has occurred to me that it might be well to consider here "Astronomy and Astronomers in Their Relations to the Public," and in doing so attempt to answer some of the questions that an intelligent public frequently asks, and at the same time indicate some of the services to both that have been rendered by astronomical societies.

The work of the astronomer, like that of other scientists, is only a little understood by the general public. Nevertheless, the relations between the two are always the most cordial; and while the astronomer may often be questioned as to the utility of his labors, he can never complain of lack of appreciation. On the contrary, the interest that attaches to a working observatory, especially one that is readily accessible, is always so great that regulations governing the admittance of visitors are indispensable, in order that any time may be reserved for scientific work.

As a result of this interest, great advantages accrue to the science. It has given the world many of its great observatories, those of the University of Chicago and of the University of California standing pre-eminent in the power of their telescopes. So great, indeed, has become the generosity of those who are not astronomers, that it would almost seem that astronomers have only to ask for instruments and observatories to find appreciative persons ready to supply their needs. This responsiveness is all the more remarkable when we consider that the results of the

astronomer's labor are, in general, far removed from commodities having a commercial value. New comets, new planets, new satellites, new stars, worlds, and systems of worlds may be discovered, and their histories may be long and interesting, but not one of them can be exchanged for real or personal property.

From what has been said, it must not be understood that astronomy has no practical applications. Far from that. The determination of time, of latitude, of longitude, of azimuth, are all problems of practical astronomy, and they are among those that have more or less important relations to the ordinary affairs of life.

The land is crossed in every direction by roads of steel. Smooth tracks, swift locomotives, and comfortable cars make travel easy and enjoyable; strong and commodious cars make it possible for cities widely separated to carry on gigantic commercial transactions. The trains glide along the tracks with great speed, and are ever meeting and passing each other. This they do with such precision that accidents are comparatively few—so few, in fact, that on the average, only one passenger out of a million and a half loses his life. This precision is due, in part, to their being controlled by some central clock. But who controls that clock? Who, with entire confidence that his statements are true, can say that the time it indicates is correct or not? Astronomers, by their long and laborious investigations, based on a multitude of refined observations, have learned the motions of the heavenly bodies with such accuracy that they can predict the positions these bodies will occupy in the sky for many years to come. They have prepared tables of these motions, giving the positions of the Sun, Moon, planets, and principal stars for given epochs. By means of these tables and astronomical observation, they can, among other things, accurately determine the time, and in no other way can it be done.

It was many years ago that the engineer applied mathematics to the pressure of the wind and pressure of the wave, and balanced the one against the other. The sail caught the wind, the hull pressed the wave, and the famous clipper ships with their precious cargoes sprang forward ten thousand miles, making records of long-distance speed that have seldom been equaled. By day and by night, the Sun, Moon, and stars, the compass, their charts, and well-rated chronometers were their faithful guides, directing their courses across the trackless oceans. The ships

found their ways, and captains delivered rich cargoes, bringing handsome returns for their voyages. Without these guides, such voyages could not have been made, and if they had not been made, the loss to commerce and civilization would have been incalculable.

The circumstances that hastened, if they did not occasion the establishment of the Royal Observatory at Greenwich, in 1675, are full of interest, and since they refer to one of the most important practical applications of astronomy, I will give a brief account of them.

At this time, a Frenchman, calling himself LE SIEUR DE PIERRE, came to the English court and announced the discovery of a method of finding the longitude of a place. Incited by the discovery of America and of routes by sea to India, the British ships were beginning to find their way to all parts of the world. Colonies were planted in many lands, and a commerce built up that has added vastly to the material wealth of England. On these long voyages, methods of finding latitude and longitude were of prime importance. It was easy enough to find latitude, but how to find longitude was a pressing problem for nearly a century after the time of which we speak.

A commission composed of distinguished men, with the privilege of adding others to their number if they saw fit, was selected to hear and consider the method proposed by LE SIEUR, and to report the results of their inquiries to the king. Among those whom the commissioners invited to join their number was JOHN FLAMSTEAD, then somewhat under thirty years of age, but with a considerable reputation because of his astronomical observations.

LE SIEUR'S method depended on the Moon's motion, and required as data the date of observation, the latitude of the place, the Moon's altitude, and the altitude of two known stars. FLAMSTEAD at once pointed out that the method was impracticable, and in the controversy that followed he wrote two letters, one to LE SIEUR and one to the commissioners. In these letters he said: "If we had astronomical tables that would give us the two places of the fixed stars and the Moon's true places, both in longitude and latitude, nearer than half a minute, we might hope to find the longitude of places by lunar observations. But that we were so far from having the places of the fixed stars true, that the Tychonic catalogues often erred ten minutes or more; * * *

and that the best lunar tables differ one quarter, if not one third, of a degree from the heavens."*

FLAMSTEAD'S letter to the commissioners was shown to King Charles. He was startled at the assertion of the fixed stars' places being false in the catalogue, and with much vehemence said: "I must have them anew observed, examined, and corrected, for the use of my seamen. I must have it done." And on being asked who could or should do it, the king replied: "The person who informs you of them."

Accordingly, on March 4, 1674–5, the king signed a warrant for FLAMSTEAD'S salary, a portion of which reads as follows:—

"Whereas, we have appointed our trusty and well-beloved JOHN FLAMSTEAD, Master of Arts, our astronomical observator, forthwith to apply himself with the most exact care and diligence to rectifying the tables of the motions of the heavens, and the places of the fixed stars, so as to find out the so much-desired longitude of places for the perfecting the art of navigation." The rest of the warrant relates to the payment of his salary, which was £100 a year.

On June 22, 1675, King Charles signed the warrant for building the observatory. It begins as follows:—

"Whereas, in order to the finding out of the longitude of places for perfecting navigation and astronomy, we have resolved to build a small observatory within our park at Greenwich, upon the highest ground, at or near the place where the castle stood, with lodging-rooms for our astronomical observator and assistant."

The foundation of the observatory was laid August 10, 1675. No provision was made for instruments. FLAMSTEAD had to provide them himself, and at his death, after forty-four years of laborious service, they "were actually claimed by the government as their own, and his executors were annoyed with a vexatious and troublesome lawsuit on that account." [BAILY: *An Account of FLAMSTEAD*, p. 30.]

The Royal Observatory at Greenwich, founded under the circumstances as related, and having especially in view the kinds of astronomical work that lead to results of practical value, has continued to the present time regularly to make those observations needed for "rectifying the tables of the motions of the heavens." It is impossible to give, or even to form, an adequate

* FLAMSTEAD'S History of his own Life in BAILY'S *Account of the Rev. John Flamstead*, page 38.

idea of the great importance of the astronomical work that has been done at Greenwich.

The long series of observations, on the principal bodies of the solar system and the brighter fixed stars, surpassing in duration and magnitude any programme of work that could reasonably be expected from any, except national observatories, is one of the richest possessions of astronomy. It has furnished the data for many of the most important investigations relating to the motions of the heavenly bodies; the determination of these motions being the principal problem that astronomers in all ages have been attempting to solve. Indeed, this problem constituted so large a part of astronomy even at the end of the first third of this century, that BESSEL, the greatest of practical astronomers, wrote as follows:—

"What astronomy is expected to accomplish, is evidently at all times the same. It must lay down rules by which the movements of the celestial bodies, as they appear to us upon the Earth, can be computed. All else which we may learn respecting these bodies, as for example, their appearance and the character of their surfaces, is, indeed, not undeserving of attention, but possesses no proper astronomical interest. Whether the mountains of the Moon are arranged in this way, or in that, is no further a subject of interest to astronomers than is a knowledge of the mountains of the Earth to others. Whether *Jupiter* appears with dark stripes upon its surface, or is uniformly illuminated, pertains as little to the inquiries of the astronomer; and its four moons are interesting to him only for the motions they have. To learn so perfectly the motions of the celestial bodies, that for any specified time an accurate computation of them can be given — that was, and is, the problem which astronomy has to solve. NEWTON gave it no new problem; but his discovery encouraged the hope that a complete solution to the old one could be obtained. This before his time was not deemed possible."

Astronomy has advanced a long way since these words by BESSEL were written. Two generations of theoretical and practical astronomers have lived since then; the former have labored to perfect the analysis relating to the motions of the heavenly bodies, and to test its accuracy by comparing observed and computed places, and the latter, following the methods of which BESSEL was the great exponent, have developed the theory of their instruments and the theory of observation with mathematical

rigor, and have neglected only those terms which could be shown to be insensible in their effects. Astronomy has also advanced with marvelous rapidity in other directions. The investigations which BESSEL characterized as not undeserving of attention, but as possessing no proper astronomical interest, together with those that have arisen through the development of spectroscopy, have unexpectedly attained such importance, and are so full of promise for the future, as to merit a co-ordinate place beside the investigations of the older astronomy, and constituting, as they do, a new science, to be distinguished by an independent name — astrophysics.

The older astronomy has lost none of its importance. There has been no halt in its progress, and no diminution in the interest that attaches to its results. This will always be the case. For so long as civilization endures, it will be a factor in the affairs of men. Besides, there are moral reasons. In common with other scientists, the astronomer must strive to a perfect understanding of the action of natural and moral forces; he cannot stop where immediate practical applications end. His researches are based on far-reaching principles, and lead to results that unfold prospects among the greatest and sublimest furnished by any department of human knowledge, and which, through the awakening and proper use of the imagination, may be classed among the most potent of moral and spiritual forces.

The investigations of the older astronomy are, from an astronomical standpoint, characterized by a singleness of purpose. Postulating the law of gravitation and the principles of rational mechanics, it seeks to determine the motions of the heavenly bodies. The newer astronomy is likewise characterized by a singleness of purpose. Calling to its aid every available means of inquiry, it endeavors to ascertain the nature and conditions of these bodies, and thence to learn what has been their past and what will probably be their future histories. Half a century ago, it seemed that the future advancement of astronomy would be along the lines already marked out, and that it would consist chiefly in perfecting the science by increasing the precision of its results. It did not then seem probable that new departments of astronomy would arise, and some of the results already obtained through astrophysical research would then have appeared, even to the boldest imagination, as hopelessly beyond human possibility. The spectroscopic and other new methods of investigation have

appeared, more and more powerful telescopes have been constructed, by the new methods and by the increase of power many old problems have been solved, but new problems in greater numbers have arisen to take their places. It will always be so. The universe is infinitely varied. A few astronomers in a few short years can at best fathom only a comparatively small number of its mysteries.

Nearly three centuries have elapsed since the invention of the telescope, and during this entire period rapid and wonderful improvements have marked its history. For more than two hundred years the popular use of the telescope was almost entirely unknown. In fact, it was not until near the middle of the present century, when the Cincinnati Observatory was established, that the great revolution in this respect was begun. The foundation of this observatory also marks an epoch in the history of science in this country.

In 1832, AIRY, "the Astronomer Royal of England, in his celebrated 'Report on Astronomy' before the British Association, after recounting with high eulogium what had been accomplished in the building of astronomical observatories throughout the old world, closes by saying, that as for the United States he did not know of the existence of a single public observatory within the limits of the entire country." It was then the general opinion abroad that the nature of our institutions was not favorable to the development of pure science. It was only ten years later, however, that the Cincinnati Astronomical Society subscribed $9500 for the purchase of an instrument, and made a provisional contract for what was then the second largest refracting telescope in the world. Since then, our observatories have rapidly increased in number, and have become no less famous for the character of their work than for the power and excellence of their telescopes.

The history of the foundation of the Cincinnati Observatory is very interesting. By a series of popular lectures, General MITCHEL, then a Professor at Cincinnati, awakened deep interest in the science of astronomy. The Cincinnati Astronomical Society was the immediate result, and thence came the Cincinnati Observatory, with its long and honorable career.

On the 9th of November, 1843, the corner stone of the observatory was laid by JOHN QUINCY ADAMS, in the presence of a vast multitude, with appropriate ceremonies, and followed by the

delivery of an address replete with beauty and eloquence. It was the intention of the board of directors to pay for their telescope before proceeding to the erection of the building. At this time only $3000 had been paid in, and to meet their engagements, $6500 would have to be collected by the following June, when it was expected the great telescope would be ready for shipment to the United States. General MITCHEL became the general agent of the society, and by undeviating perseverance raised the entire sum before the specified time had expired. But after paying for the instrument, not one dollar in cash remained with which to begin the construction of the observatory building, which, at the lowest estimate, must cost five or six thousand dollars. Some two or three thousand dollars had been subscribed, payable in work and materials; a suitable site on the summit of Mt. Adams had been given, subject to certain conditions; but no one could be found who would take the contract for the building in the face of the many contingencies by which the affairs of the society were surrounded. General MITCHEL determined to hire workmen by the day, and personally to superintend the erection of the building. In attempting to contract for the delivery of brick on the summit of Mt. Adams, he was asked such a high price for the hauling, on account of the steepness of the hill, that all idea of a brick building was at once abandoned, and it was decided to build of limestone, an abundant supply of which could be had on the grounds of the society by quarrying. The exorbitant charges made for delivering lime were at once disposed of by building a limekiln on the grounds. In a few days it was completed, filled, and on fire, and soon lime in abundance was ready. Sand was the next item for which extravagant charges were made. With considerable difficulty, permission was obtained to open a sandpit not far away, which had long been closed for fear that further excavation would endanger a house on the hill above it. Then the price asked for hauling the sand was so great that General MITCHEL was forced to buy horses, and in not a few cases to fill the carts with his own hands and drive them to the top of the hill, in order to demonstrate practically how many loads could be fairly made in a day. The nearest water was at the foot of the hill, half a mile away. To avoid hauling so far, a dam was thrown across one of the deepest ravines on the hilltop, and the rains allowed to fill it, to furnish the water needed for mixing the mortar.

The work of construction began early in June, 1844. The force of hands for the first week consisted of two masons and one man to tend them. With this force it would have taken about twenty years to have erected the building, yet according to the bond it must be completed by the following June, or the title to the site must be forfeited.

By the end of the first week, General MITCHEL had raised enough money to pay his hands. He instructed his foreman to double his force for the next week. At the end of it, he had again obtained sufficient money to pay them in full. The force was increased week after week in the same manner, until not less than fifty day laborers were actually engaged in the erection of the Cincinnati Observatory, and as many more in the shops in the city were paying their subscriptions by work for the different parts of the building. The doors were being made by one carpenter, the window frames by another, the sashes by a third, a painter took them from the joiner, and in turn delivered them to the glazier, and finally a carpenter paid his subscription by hanging them, using locks, hinges, cords, pulleys, and weights, all obtained by subscription.

Each Saturday night saw the funds exhausted; each new week was commenced in the full confidence that industry and perseverance would work out its legitimate results. To raise the cash means was the greatest difficulty. Frequently, four or five trades had to be made to convert due bills into cash, and not infrequently did individuals cash their own due bills at a discount.

In July and August, the work went on rapidly, and in September, General MITCHEL had the great satisfaction of seeing the building up and covered, without having incurred one dollar of debt and without neglecting his duties as Professor of Mathematics and Philosophy in the Cincinnati College, where he was teaching five hours a day.

By the terms of the subscription, each contributor, whether of cash, work, or material, became a member of the Cincinnati Astronomical Society, and came to have a personal interest for himself and for his family, in this important observatory and its great telescope. There were about 800 contributors, from all professions and all ranks of society; probably not less than 4000 persons had acquired the right to look at the heavenly bodies through this, the then second largest refractor in the world. At first, many nights were devoted to their instruction and enter-

tainment; for the first year, only one night each week was reserved for scientific work, and in the second year, only three nights each week.

We have now noted, briefly, the circumstances attending the founding of two important public observatories,—one by royal favor, the other by the will of the people. Both have long and honorable careers; both have served as examples leading to the establishment of other observatories, and both have ministered to the wants of the people, though in very different capacities.

A little more than three quarters of a century ago the Astronomical Society of London was organized, and the objects of the original members are stated in an address circulated before their first public meeting, in the following words:—

"To encourage and promote their peculiar science by every means in their power, but especially by collecting, reducing, and publishing useful observations and tables; by setting on foot a minute and systematic examination of the heavens; by encouraging a general spirit of inquiry in practical astronomy; by establishing communication with foreign observers; by circulating notices of all remarkable phenomena about to happen, and of discoveries as they arise; by comparing the merits of different artists eminent in the construction of astronomical instruments; by proposing prizes for the improvement of particular departments, and bestowing medals or rewards on successful research in all; and finally, by acting, as far as possible, in concert with every institution, both in England and abroad, whose objects have anything in common with their own, but avoiding all interference with the objects and interests of established scientific bodies."

Surely, this was an ambitious program of work for a new society, and that it was able to carry it out in full measure demonstrates that its council contained masterly ability, and that its affairs were wisely and carefully administered. Its success from the beginning was far beyond expectation. In its first list of members and associates, we find many distinguished names. BABBAGE, BREWSTER, FARADAY, HERSCHEL, ARAGO, BESSEL, GAUSS, LAPLACE, OLBERS, PIAZZI, and STRUVE are among the number. The funds of the society grew, and were carefully invested. Even at the "first annual general meeting" the council was able to report that the invested funds amounted to more than $3700. Presents of books, papers, and

instruments have been continually received for more than seventy-five years, so that at the present time the property, aside from investments, is so extensive that insurance to the extent of £5500, or, approximately, $27,500, is no longer regarded as sufficient. Its library has always been accessible at all reasonable hours, and a generous spirit has prevailed in regard to its instruments. In its very infancy it began the publication of its *Memoirs*, those substantial astronomical papers intended for the advancement of science, which, in the aggregate, now number more than 15,000 quarto pages. Just seventy years ago it added to its publications the *Monthly Notices*, which are now in their fifty-seventh volume.

The society soon became, and still continues to be, a great force in the astronomical world. The great value of its publications, the interest in its regular monthly meetings, the advantages arising from its library and many other privileges have combined to make it popular at home and abroad. It has aided in the advancement of science in a purely technical way; and again by bringing science and the people closer together, to the great benefit of both.

The society's early success was attributed by its members themselves to the policy adopted in the beginning, "by acting in concert with every institution, both in England and abroad, whose objects have anything in common with its own; but avoiding all interference with the objects and interests of established scientific bodies." To this may be added the active and sincere co-operation of its ablest members, without which the healthy growth and prosperity of a scientific society is impossible, and which can only exist when, in the management, there is entire freedom from direction such as wielded by the typical political boss.

The Astronomical Society of the Pacific has been in existence about eight years. Its energies have been devoted to the diffusion of astronomical knowledge by means of popular lectures and by its *Publications*. In this way its services have been valuable to the public and to astronomers. The welfare of the Society demands that work along these lines shall be continued, and that it shall be made as good in quality as can be obtained, and as large in quantity as is consistent with an economical management. An increase in the membership of the Society is eminently desirable, for this would mean an increase of its funds, of its possibilities, and of its responsibilities. The limits of its

usefulness will not be reached until it becomes an active force, stimulating and encouraging astronomical research in all its departments, and spreading astronomical knowledge to all classes.

San Francisco should have a great astronomical library. Nothing could be more appropriate than that this should be the property of the Astronomical Society. A beginning in this direction has already been made. There are now some funds for library purposes, there should be more; and from time to time, valuable books and papers are being received from corresponding institutions and from individuals. Every gift in this way is welcomed; all works on astronomy and the related sciences have a value in such a place.

Since the Society is very largely composed of those who are not professional astronomers, it may be said that the library need contain only popular works. But this is plainly not enough. It should be technical as well as popular, and as soon as may be, complete in the periodical literature of the science. During the past year, in connection with my Presidency of the Society, I have learned of more than one case of young persons of this city who are interested in the science, not as amateurs, but with the expectation of becoming professional astronomers. To these the Society has a duty, that of providing library facilities commensurate with their aims. Such persons, if of marked ability, soon largely outgrow popular books, and demand the works of the masters and the entire range of periodical literature to satisfy their wants.

ASTRONOMICAL OBSERVATIONS IN 1896.

Made by TORVALD KÖHL, at Odder, Denmark.

VARIABLE STARS.

Z Cygni.

January	8:	Z = d.
	13:	< d. > e.
	18:	= e.
February	15:	< e.
May	5:	< e.
	9:	< e.
August	15:	> f. < 26.
	30:	a little > b.
September	8:	= b.
September	26:	< c. > d.
	30:	id.
October	8:	< d. > e.
	11:	a little > e.
	26:	= e.
	28:	= e.
	30:	= e.
November	4:	< e.
	7:	< e.
	8:	< e.

X^2 Cygni.

January	8:	> a. < A.
	13:	id.
	18:	almost = A.
	19:	id.
May	7:	= g'.
	9:	id.
August	15:	invisible.
	17:	id.
September	26:	id.
October	8:	a little < k.
	26:	id.
	28:	id.

The Stars A and B, near X^2 Cygni.

January	8:	A < B.
	13:	A = B.
	18:	id.
	19:	id.
May	5:	A < B.
	7:	id.
	9:	A = B.
August	15:	A < B.
	17:	A = B.
	18:	id.
	30:	A < B.
September	3:	id.
	8:	A = B.
	26:	id.
	30:	A < B.
October	8:	A < B. Distinct
	11:	A < B.
	26:	id.
	28:	id.
	30:	A = B.
November	4:	A < B.
	8:	A = B.

1897, January 1: A > B. N. B.

S Ursæ majoris.

January	8:	S = f.	September	3:	faint.
	13:	a little < f.		4:	= g.
	19:	= g.		8:	id.
February	15:	id.		26:	almost invisible.
March	11:	= f'.		30:	id.
	17:	a little > f'.	October	8:	invisible.
	20:	> f.		26:	almost invisible.
	31:	< e.		28:	= g.
May	1:	= d.	November	4:	= f.
	9:	id.		7:	id.
August	18:	= f.			
	30:	a little < g.			

T Ursæ majoris.

January	8:	T a little > a.	September	3:	a little > b.
	13:	> a.		4:	id.
	19:	a little > a.		8:	> b.
February	15:	= b.		26:	> a.
March	11:	= e.		30:	a little > a.
	17:	id.	October	8:	id.
	20:	id.		26:	{ < b. > c. }
May	1:	invisible.		28:	almost = c.
	9:	id.	November	4:	= c.
August	18:	a little > e.		7:	a little < c.
	30:	{ > c. < b. }			

The Lunar Eclipse of February 28th.

h.	m.		
7	16 P. M.	. . .	Shadow touching limb of Moon.
	30	. . .	Shadow touching *Sirsalis a. Heraclides.*
	33	. . .	Shadow touching *Cap Laplace.*
	38	. . .	Shadow touching *Plato.*
	40	. . .	Shadow touching *Copernicus.*
	42	. . .	Shadow touching *Gassendi* East.
	44	. . .	Shadow touching *Gassendi* West.
	48	. . .	Shadow touching *Mare serenitatis* East.
	55	. . .	Shadow touching *Bessel.*
8	9	. . .	Shadow touching *Proclus.*

h.	m.		
	20	P. M.	Shadow touching *Tycho* East.
	46		(Maximum)
9	17		Shadow touching *Grimaldi.*
	43		Shadow touching *Copernicus.*
	47		Shadow touching *Heraclides.*
	52		Shadow touching *Cap Laplace.*
	57		Shadow touching *Plato* East.
	58.5		Shadow touching *Plato* West.
10	5		Shadow touching *Aristoteles.*
	7		Shadow touching *Proclus.*
	15		Shadow touching limb of Moon.

OCCULTATION OF THE PLEIADES.

h.	m.	s.	
8	55	45	Immersion of *Celeno.*
	59	30	Immersion of *Electra.*
9	16	40	Immersion of *Taygeta.*
	23	40	Immersion of *Maya.*
	40	30 (?)	Immersion of *Asterope*[1]. Emersion of *Electra.*
	53	40	Emersion of *Celeno.*
10	5	40	Emersion of *Taygeta.*
	22	50	Emersion of *Maya.*

SHOOTING STARS.

No.	Time, P. M.	Beginning.	End.	Magnitude.	NOTE.
	1896.	° °	° °		
1	Aug. 9 . 10^h 3^m 30^s	237+ 8	234− 3	♀	
2	8 0	1+29	1+29	1	
3	10 20	343+11	335+ 6	3	
4	22 0	300+48	289+40	3	
5	23 30	292+10	286+ 4	3	
6	33 0	348+18	342+14	2	
7	35 0	270+56	242+75	1	
8	38 20	337+30	330+20	2	
9	39 0	345+65	340+49	♀	
10	42 0	292+ 3	291− 4	1	
11	42 15	294+26	282+10	⅓☾	Fireball.
12	48 10	322+70	306+58	1	
13	50 0	290+52	275+30	2	
14	53 45	245+63	206+58	2	
15	58 10	298+50	288+42	3	
16	59 15	344+43	331+30	3	
17	11 1 0	303+20	294+ 5	2	
18	4 40	25+30	24+14	♀	
19	8 0	303+45	287+29	3	
20	11 10	309−11	301−19	1	
21	18 30	240+33	225+22	3	
22	22 30	307−10	301−16	3	
23	26 0	13+19	3+ 6	♀	Train.
24	31 30	309−17	301−23	1	
25	39 30	27+32	27+22	♀	
26	43 15	288+10	284+ 0	2	
27	50 40	323− 7	312−13	3	
28	51 20	18+32	3+22	¼☾	Fireball.
29	56 15	318+50	304+40	2	
30	59 0	66+75	40+86	2	
	Time, A. M.				
31	Aug. 10 . 12 2 —	328+43	312+32	3	
32	3 —	330+ 2	322− 4	3	
	Time, P. M.				
33	10 1 10	339− 2	331−14	♃	
34	2 50	341+40	324+18	♃	
35	5 50	295+61	270+34	♀	Train.
36	7 20	0+58	335+50	1	
37	13 0	321+44	305+40	2	
38	13 30	323+ 9	310− 5	♃	
39	15 0	351+10	340− 5	♃	
40	18 30	332+56	310+44	1	

SHOOTING STARS —*Continued.*

No.	Time, P. M.	Beginning.	End.	Magnitude.	Note.
	1896.	° °	° °		
41	Aug. 10. $10^h\ 21^m\ 45^s$	10+40	359+23	2	
42	25 40	10+25	6+19	1	
43	33 40	10+37	19+40	3	
44	35 0	263+36	243+12	♀	
45	39 0	258+39	244+23	2	
46	44 45	303+ 2	295—13	2	
47	47 15	293+26	280+ 5	1	
48	50 30	337+ 9	342—15	2	
49	51 50	348+22	342+13	1	Train.
50	56 50	50+70	64+73	1	
51	57 0	35+29	31+19	2	
52	59 50	303— 8	302—18	1	
53	11 2 20	328—15	324—23	1	
54	4 0	342+33	331+21	♃	Train.
55	11 50	319— 5	307—14	♀	Train.
56	14 50	25+34	16+22	1	
57	15 0	266+56	277+42	♃	
58	17 0	40+60	74+64	1	
59	28 0	10+29	1+17	1	
60	35 0	102+45	102+39	♀	
61	35 30	310+30	298+11	♃	
62	37 40	29+16	25+ 6	♃	
63	42 0	346+ 0	339—14	2	
64	45 0	311+14	301— 2	2	
65	45 20	20+27	42+30	2	Slow, undulated light.
66	58 10	16+46	4+36	♀	Train.
67	12 0 0	26+19	21+ 6	1	
68	Aug. 11. 10 10 30	185+50	195+34	1	
69	11 0	148+50	175+29	2	
70	16 40	183+34	190+22	1	
71	24 50	316+33	292+20	1	
72	27 20	337+37	318+22	1	Train.
73	32 20	339+75	319+59	4	
74	45 10	170+80	160+75	3	
75	55 45	5+36	353+24	2	
76	11 2 30	25+20	23+13	2	
77	4 0	27+55	21+50	2	
78	5 0	10+39	358+30	2	
79	10 0	4+ 9	359+ 4	2	
80	Aug. 12. 9 57 30	. . . .	70+70	2	

No. 23 was also observed at Copenhagen ($356° + 30° + > 341° + 18°$, 1 Magnitude).

No. 28 was also observed at Copenhagen ($290° + 57° + > 273° + 42°$, ♃).

No. 77 was also observed at Copenhagen ($248° + 40° + > 254° + 27°$, 1 Magnitude).

These three meteors give the following results:—

No.	Beginning.			End.			Real Length of the Path.
	h	λ	ϕ	h	λ	ϕ	β
		° ′	° ′		° ′	° ′	*Km.*
23				120	1 23 East.	54 54	
28				98	0 57 West.	55 32	
77	107	1 17 West.	55 43	101	1 27 West.	55 25	35

Odder is situated in 2° 25′ W. longitude from Copenhagen, and 55° 58′ N. latitude. h and β indicate kilometres; λ is longitude from Copenhagen; ϕ is N. latitude.

NOTE.—This paper was accompanied by a drawing of five phases of the occultation of *Jupiter* by the Moon on 1896, June [illegible]4. The drawing is not reproduced here. The radius of *Jupiter* is taken as 9 *mm.* 2.5 *mm.* were obscured at $10^h 42^m 50^s$; 8.3 *mm.* at $10^h 43^m 10^s$; 14 *mm.* at $10^h 43^m 30^s$. The middle time is that of bisection, according to a late note from Mr. KÖHL.

THE COMMITTEE ON PUBLICATION.

PLANETARY PHENOMENA FOR MAY AND JUNE, 1897.

By PROFESSOR MALCOLM MCNEILL.

MAY.

Mercury is an evening star until May 20th, when it comes to inferior conjunction with the Sun. It passed greatest east elongation on April 28th, and during the first ten days of the month is in very good position for observation, not setting until nearly two hours after sunset on May 1st.

Venus is now a morning star, having passed inferior conjunction on April 28th. It is too near the Sun to be seen during the early part of the month, but its distance rapidly increases, and after May 10th it rises more than an hour before sunrise. On May 1st, there is a very close conjunction of the Sun, Moon and *Venus;* the Moon passes the planet at about 3 A. M., and the Sun at 1 P. M. Of course, both Moon and planet are too near the Sun to be seen.

Mars is still in the southwestern sky in the evening, but sets an hour earlier than for the corresponding period in April, at a little after 11 P.M. on May 30th. It moves about eighteen degrees east and four degrees south during the month from the constellation *Gemini* into *Cancer.* On the morning of May 25th, it passes just south of the fifth magnitude star η *Cancri*, the nearest distance being only two minutes, but this is while they are below our horizon. During the closing days of the month it passes through the "Beehive" cluster in *Cancer.* The planet has nearly reached its maximum distance from the Earth, and it will not diminish very greatly in brightness before reaching its minimum. It passes aphelion on the night of May 21st.

Jupiter is also in the southwestern sky in the evening, setting after midnight. It is in the constellation *Leo,* and during the month it moves about two degrees east and forty minutes south. At the beginning of the month it is about two degrees east of the first magnitude star *Regulus* (α *Leonis*).

Saturn rises at about sunset in the middle of the month, coming to opposition on the night of May 17th. It moves west in the constellation *Libra* about two degrees during the month. At the beginning of the month it is about three degrees west of the third magnitude star β *Scorpii.*

Uranus is quite close to *Saturn*, about two degrees south. It comes to opposition on the same date as *Saturn*, May 17th, but about twelve hours earlier. Its motion is like that of *Saturn*, but only about half as great.

Neptune is in the eastern part of the constellation *Taurus*, too close to the Sun for observation.

JUNE.

The Sun attains its maximum declination at the summer solstice, and summer begins June 20th, 8 P. M., P. S. T.

Mercury is a morning star, and reaches greatest west elongation on June 15th. It is several degrees south of the Sun, and

the conditions are not very good for visibility; but after June 10th it rises at least an hour before the Sun, and it may possibly be seen if the atmospheric conditions are very favorable.

Venus is also a morning star, and is rapidly increasing its distance from the Sun, so that by the end of the month it has nearly reached greatest west elongation. It reaches its maximum brightness early in the month, and during most of the month it can be seen in full sunlight without telescopic aid.

Mars sets about an hour earlier than during May, at about 10 P. M. on June 30th. It moves about seventeen degrees east and six degrees south during the month, through the constellation *Cancer* toward *Leo*, and at the end of the month is only about two degrees west and north of *Regulus* (α *Leonis*). Its actual distance from the Earth is about twice the mean distance of the Earth from the Sun, and its brightness not far from its minimum.

Jupiter is somewhat to the east and south of *Mars*, and moves about four degrees east and two degrees south during June, in the constellation *Leo*, away from *Regulus*. At the end of the month it is ten degrees east and four degrees north of *Mars*, *Regulus* lying between the planets and nearer *Mars*.

Saturn is now well above the horizon at sunset. It moves about two degrees west in the eastern part of the constellation *Libra* away from β *Scorpii*. The apparent minor axis of the ring is four-tenths that of the major.

Uranus is just about two degrees south of *Saturn*, and moving in the same direction, but more slowly. It is in conjunction with *Saturn* on June 8th.

Neptune is a morning star, quite close to the Sun.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the

phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

PHASES OF THE MOON, P. S. T.

			H. M.
New Moon,	May	1,	12 46 P. M.
First Quarter,	May	9,	1 37 P. M.
Full Moon,	May	16,	5 54 A. M.
Last Quarter,	May	23,	1 34 A. M.
New Moon,	May	31,	4 26 A. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
May 1.	2 36	+15 15	5 4 A.M.	11 57 A.M.	6 50 P.M.
11.	3 14	+18 1	4 53	11 56	6 59
21.	3 54	+20 18	4 44	11 56	7 8
31.	4 34	+22 0	4 38	11 57	7 16
			MERCURY.		
May 1.	3 55	+23 5	5 54 A.M.	1 17 P.M.	8 40 P.M.
11.	4 9	+22 21	5 30	12 51	8 12
21.	3 54	+18 51	4 49	11 56 A.M.	7 3
31.	3 39	+15 46	4 7	11 2	5 57
			VENUS.		
May 1.	2 12	+18 12	4 29 A.M.	11 33 A.M.	6 37 P.M.
11.	1 56	+14 18	3 49	10 38	5 27
21.	1 54	+11 45	3 16	9 56	4 36
31.	2 5	+11 1	2 50	9 28	4 6
			MARS.		
May 1.	7 30	+23 37	9 25 A.M.	4 51 P.M.	12 17 A.M.
11.	7 54	+22 35	9 14	4 35	11 56 P.M.
21.	8 17	+21 19	9 3	4 19	11 35
31.	8 41	+19 51	8 54	4 4	11 14
			JUPITER.		
May 1.	10 11	+12 33	12 48 P.M.	7 31 P.M.	2 14 A.M.
11.	10 12	+12 25	12 10	6 53	1 36
21.	10 15	+12 11	11 34 A.M.	6 16	12 58
31.	10 18	+11 51	10 59	5 40	12 21

Saturn.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
May 1.	15 48	−17 39	8 12 P.M.	1 11 A.M.	6 10 A.M.
11.	15 45	−17 30	7 30	12 29	5 28
21.	15 42	−17 20	6 42	11 42 P.M.	4 42
31.	15 39	−17 11	6 0	11 0	4 0

Uranus.

May 1.	15 42	−19 26	8 14 P.M.	1 5 A.M.	5 56 A.M.
11.	15 40	−19 20	7 32	12 24	5 16
21.	15 38	−19 15	6 47	11 39 P.M.	4 31
31.	15 37	−19 9	6 5	10 58	3 51

Neptune.

May 1.	5 11	+21 37	7 15 A.M.	2 32 P.M.	9 49 P.M.
11.	5 12	+21 39	6 37	1 54	9 11
21.	5 14	+21 41	5 59	1 16	8 33
31.	5 15	+21 43	5 20	12 38	7 56

Eclipses of *Jupiter's* Satellites, P. S. T.

(Phenomena near right-hand limb of planet as seen in an inverting telescope.)

		H. M.			H. M.
III, D,	May 1.	10 56 P. M.	II, R,	May 9.	10 47 P. M.
III, R,	2.	2 16 A. M.	I, R,	12.	10 8 P. M.
II, R,	2.	8 11 P. M.	I, R,	21.	6 31 P. M.
IV, D,	3.	6 18 P. M.	II, R,	27.	5 14 P. M.
IV, R,	3.	10 21 P. M.	I, R,	28.	8 26 P. M.
I, R,	4.	1 44 A. M.	III, R,	30.	6 12 P. M.
I, R,	5.	8 13 P. M.			

Minima of *Algol.*

The Sun is too near the star, and the star too near the horizon, for convenient observation of minima.

Phases of the Moon, P. S. T.

		H. M.
First Quarter,	June 7,	11 2 P. M.
Full Moon,	June 14,	1 1 P. M.
Last Quarter,	June 21,	3 24 P. M.
New Moon,	June 29,	6 55 P. M.

The Sun.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
June 1.	4 39	+22 8	4 38 A.M.	11 58 A.M.	7 18 P.M.
11.	5 20	+23 8	4 35	11 59	7 23
21.	6 1	+23 27	4 37	12 2 P.M.	7 27
July 1.	6 43	+23 5	4 41	12 4	7 27

Mercury.

1897.	A. R. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
une 1.	3 38	+15 37	4 3 A.M.	10 57 A.M.	5 51 P.M.
11.	3 49	+16 4	3 33	10 29	5 25
21.	4 28	+19 4	3 21	10 28	5 35
uly 1.	5 34	+22 35	3 33	10 54	6 15

Venus.

une 1.	2 6	+11 2	2 47 A.M.	9 25 A.M.	4 3 P.M.
11.	2 28	+11 51	2 27	9 8	3 49
21.	2 57	+13 32	2 10	8 57	3 44
uly 1.	3 31	+15 35	1 58	8 52	3 46

Mars.

une 1.	8 43	+19 41	8 52 A.M.	4 2 P.M.	11 12 P.M.
11.	9 6	+18 0	8 43	3 46	10 49
21.	9 30	+16 7	8 34	3 30	10 26
uly 1.	9 53	+14 4	8 26	3 14	10 2

Jupiter.

une 1.	10 18	+11 48	10 56 A.M.	5 36 P.M.	12 16 A.M.
11.	10 22	+11 23	10 21	5 1	11 41 P.M.
21.	10 27	+10 52	9 49	4 27	11 5
uly 1.	10 33	+10 18	9 18	3 53	10 28

Saturn.

une 1.	15 39	−17 10	5 56 P.M.	10 56 P.M.	3 56 A.M.
11.	15 36	−17 2	5 13	10 14	3 15
21.	15 33	−16 55	4 31	9 32	2 33
uly 1.	15 32	−16 50	3 49	8 51	1 53

Uranus.

une 1.	15 37	−19 9	6 2 P.M.	10 54 P.M.	3 46 A.M.
11.	15 35	−19 3	5 20	10 13	3 6
21.	15 34	−18 59	4 39	9 32	2 25
uly 1.	15 33	−18 55	3 59	8 52	1 45

Neptune.

une 1.	5 15	+21 43	5 17 A.M.	12 35 P.M.	7 53 P.M.
11.	5 17	+21 45	4 39	11 57 A.M.	7 15
21.	5 19	+21 47	4 1	11 19	6 35
uly 1.	5 20	+21 48	3 23	10 41	5 59

Eclipses of *Jupiter's* Satellites, P. S. T.

(Phenomena near right-hand limb of planet as seen in an inverting telescope.)

			H. M.				H. M.
II, R,	June	3.	7 50 P. M.	I, R,	June	13.	6 45 P. M.
I, R,		4.	10 22 P. M.	I, R,		20.	8 41 P. M.
II, D,		6.	6 55 P. M.	II, R,		28.	4 50 P. M.
II, R,		6.	10 11 P. M.	I, R,		29.	5 4 P. M.
II, R,		10.	10 24 P. M.				

Minima of *Algol.*

The Sun is too near the star, and the star too near the horizon, or convenient observation of minima.

EPHEMERIS FOR PHYSICAL OBSERVATIONS THE MOON FOR CERTAIN DATES BETWEEN 1890 AND 1896.

COMMUNICATED BY DR. A. MARTH, F. R. A. S.

NOTE.—Dr. MARTH has been so good as to comput following table, corresponding to times at which certain neg of the Moon have been taken at Mt. Hamilton with the thirt inch refractor. The times usually correspond to focal neg presented by the Lick Observatory to the Observatory of Pı The last entry refers to Map No. 1 of the Observatory At the Moon, published by the Lick Observatory. It is Dr. MA: intention to continue these computations. E. S.

Date.		Pacific S. T.			Selenographical Colong. of the Sun.	Selenographical Latit. of the Sun.	Topocentric Libration. Longit.	Topocentric Libration. Latit.	Apparent Semi-diam of ☾'s Disc.
		h.	m.	s.	°	°	°	°	″
1890, June	29	10	10		63.70	+0.40	−5.72	−1.22	982.6
		10	23		63.81	+0.40	−5.75	−1.20	982.7
July	20	7	53		319.23	+0.88	−4.56	−5.89	893.6
	27	10	27		46.08	+1.05	−7.56	0.00	978.9
Aug.	31	14	27		115.43	+1.51	+5.62	+6.66	992.3
Nov.	16	5	53		329.70	+0.55	−2.49	+4.88	973.2
	17	6	8	35	342.01	+0.53	−1.42	+6.09	976.2
1891, July	13	8	24	57	3.60	+1.13	−4.04	−3.85	901.9
	28	14	51	5.5	189.91	+1.37	+6.59	+1.88	955.1
Oct.	12	7	29	9	33.97	+0.97	−5.84	+7.51	981.8
	—	7	30	54.5	33.98	+0.97	−5.85	+7.51	981.8
1892, Nov.	10	14	54	31	172.43	−0.35	+8.58	−6.50	935.5
	—	15	52	41	172.92	−0.35	+8.43	−6.49	937.0
1893, July	20	8	22	45	0.58	+1.52	+4.64	+1.92	903.1
	23	8	27	53	37.25	+1.52	+0.94	+5.51	891.4
Aug.	3	15	23	13	174.93	+1.44	−4.06	−0.70	972.6
	—	15	30	45	174.99	+1.44	−4.07	−0.72	972.8
Aug.	29	13	13	48 5	131.43	+1.07	−3.77	+1.25	966.7
Oct.	26	10	50	52	117.48	−0.41	+0.01	−4.13	1003.9
	—	16	3	14	120.12	−0.42	−0.27	−4.60	1004.1
1894, Nov.	8	10	16	52	45.27	−1.14	−5.41	+0.76	922.5
	—	10	21	1.5	45.30	−1.14	−5.42	+0.76	922.4
1895, June	27	8	21	1.5	338.66	+1.43	+3.68	+1.00	982.6
Aug.	2	10	1	36	59.41	+0.86	+4.84	+6.59	904.0
	—	11	43	3	60.27	+0.86	+4.46	+6.48	902.9
	—	11	44	41	60.28	+0.86	+4.46	+6.48	902.9
	7	15	25	11	123.10	+0.73	−2.13	+0.09	893.1
	13	15	10	26	196.21	+0.57	−7.01	−6.19	941.2
	14	16	17	26.5	209.00	+0.54	−6.83	−6.46	957.6
	—	16	20	6.5	209.02	+0.54	−6.84	−6.45	957.7
Sept.	6	15	38	22	129.57	−0.06	−4.80	−3.82	903.1
Oct.	7	13	56	8	146.77	−0.87	−5.81	−6.45	933.9
	8	14	41	2	159.32	−0.89	−5.94	−6.48	943.9
	9	16	20	2	172.34	−0.91	−5.96	−6.12	956.0
	—	16	36	20	172.48	−0.91	−6.01	−6.11	956.3
	10	16	49	13.5	184.77	−0.93	−5.48	−5.34	967.6

The topocentric libration gives the selenographical longitude and latitude of the point on the Moon's surface which occupies the center of the disc, as seen from the Lick Observatory. P. denotes the position-angle of the Moon's axis, reckoned from the apparent circle of declination.*

REVIEW OF SOLAR OBSERVATIONS, 1895 (AUGUST–DECEMBER) AND 1896.

By David E. Hadden.

The following solar observations are a continuation of those communicated to the Society for the years 1891 to June, 1895, and published in Vol. VII., No. 45, of the *Publications.*

The instrumental outfit used has remained the same, viz.: a three-inch equatorially mounted telescope, and a grating spectroscope of 14,438 lines to the inch.

During the year 1896 the appearance and approximate position and size of each sun-spot group and facula have been sketched daily on sheets of paper containing a three-inch ruled circle, divided into quadrants, the east and west line being set parallel with the Sun's apparent motion, by allowing the limb of Sun's image to move tangent to the horizontal spider-line in the eye-piece; the observations are afterward properly corrected for position-angle of the Sun's axis and inclination to the ecliptic. By this means an approximate position of the latitude and longitude is obtained.

Complete observations and detailed descriptions of the results have been published in the *Monthly Review of the Iowa Weather and Crop Service.*

The following tables exhibit the summaries of these observations:—

RESUMÉ OF SOLAR OBSERVATIONS.

1895.

Months.	Number of Observing Days.	Mean Daily Number of Groups.	Spots.	Faculæ.
July	3	. .	. .	. .
August	22	4.7	43.9	2.9
September	19	5.1	22.3	2.8
October	20	4.6	35.5	3.3
November	16	3.9	16.2	2.9
December	17	6.3	27.1	2.9

*For a continuation of this article see the *Notices* L. O.

1896.

January	9	3.2	8.5	3.2
February	18	3.8	24.0	2.5
March	16	3.7	14.8	2.6
April	17	3.7	21.8	3.2
May	18	2.3	10.7	2.5
June	16	3.0	23.1	2.3
July	23	3.8	15.1	2.7
August	20	2.2	10.7	2.6
September	17	2.9	31.2	3.3
October	21	2.8	12.9	2.6
November	12	3.6	16.0	3.2
December	10	4.0	24.7	3.6

The steady decline in number of groups and spots noted : having set in during 1894 and the first half of 1895 has continue during the period under review, several days without spots beir noted in April, August, and October, 1896. Among the larg and more noteworthy groups observed may be mentioned tl following:—

August, 1895.—Several large and interesting groups from 1 to 14th. On the 27th, a fine, single spot, with double umbr appeared at the east limb and completed the transit of the dis disappearing at the west limb on September 9th, and reappearir again by rotation at the east limb on September 23d, and on again completing the transit; its umbra was quite interestir from day to day, at times being single, double, round, irregula and curved. Other large groups were noticed during the closir days of September and fore part of October, and again durir the third decade of that month.

On September 24th, a fine, bright protuberance was observe on the east limb.

On October 12th, a large stemmed prominence was on tl west limb, near a group which was disappearing by rotation.

On October 20th, faint reversals and distortions of the H line were observed on the east edge of the large east group spots.

November 1st to 9th, large groups and spots dotted the disc

December 20th to close of the month, a number of fairly larg and very interesting groups crossed the disc.

The following synopses of my observations for each month the year 1896 are reprinted from the *Iowa Monthly Weath Review*:—

January, 1896. Sun-spots were few and small during the month of January, but three groups made the entire transit of the disc from east to west during the period, and nearly twice as many groups were noted in the southern as in the northern hemisphere.

February, 1896. The sun-spots for the first half of February, 1896, were small, but during the latter half two especially fine and interesting groups made the transit of the disc. Twice as many groups were noted in the north as in the south hemisphere in the first half of the month, while during the latter half there was a slight increase in favor of the southern.

March, 1896. The total number of sun-spot groups noted during the month of March, 1896, was about the same as for the preceding month, but they were smaller and contained a less number of spots.

But three groups made the transit of the disc, the remaining groups being of a very transitory character; the average life of all groups visible was 2.8 days per group. A fairly large group appeared on the 26th, but after passing the central meridian about April 1st, it seemed to be fading out in small spots.

April, 1896. The average daily number of sun-spot groups for the month of April, 1896, was about the same as for the preceding three months, but the individual spots were much smaller. But one fairly large group was noticed during the month, namely, on the 10th.

From the 14th—the date of next observation—until the 18th, the Sun's disc was free from dark spots. This is the first time since August, 1891, that the disc has been entirely clear. A minimum also occurred in November, 1895, when a few days were noted in which but one very faint group was present.

From April 20th to 26th the groups were all small and transient.

The average daily number of groups was about the same in both northern and southern hemispheres during the month.

May, 1896. Sun-spots during the first twenty-five days of May, 1896, were few, small, and uninteresting. On the 26th, an extensive group of small spots suddenly appeared, which rapidly increased in size and activity, and at the close of the month was a very conspicuous group of much interest.

Compared with the preceding four months of the year, there was a decided falling-off in the daily average number of groups, spots, and faculæ, evidence of the approaching minimum of solar activity.

June, 1896. Large and interesting groups of spots were visible on the solar disc during the entire month of June, 1896, with the exception of a day or two about the 20th, and the three closing days of the month. The average number of groups was three per day, 2.1 of which were observed in the southern hemisphere. Five groups made the entire transit of the disc, while one originated on the visible side and completed the transit during the month.

July, 1896. Sun-spots for the first eleven and last eight or ten days of July, 1896, were few and small. On the 12th, a large spot appeared at the southeast limb, which completed the transit of the disc and dis-

appeared at the west limb on the 25th. This group was the most important one of the month, and proved quite interesting, undergoing many changes from day to day. Another group appeared on the northeast limb on the 14th with indications of much activity; it rapidly increased in size in the next few days, but had entirely disappeared when near the central meridian on the 20th. As in the preceding two months, the southern hemisphere was the region of greatest frequency of spot groups. But three groups completed the entire transit of the disc from east to west during the month.

August, 1896. The daily average number of sun-spots visible during the month of August, 1896, was the lowest so far in the present year, being but 2.2 per day. Five groups completed the transit of the solar disc from east to west during the month. The principal group of the month appeared by rotation on the 9th—a large, well-defined circular spot with nucleus and penumbra, which changed but little during its transit. On the three closing days of the month, several new and fairly large groups appeared, which were of interest. The southern hemisphere was again the location of greatest frequency of disturbances.

Sep'ember, 1896. Sun-spots from September 1st to 8th were few and small. On the 9th, a fine extended stream of spots appeared at the east limb and made the transit of the disc. It was one of the longest groups observed in many years; owing to cloudy weather, but few observations of it were possible; before reaching the west limb it rapidly became smaller, the spots breaking up and fading out, not to reappear again by rotation at the east limb. The southern hemisphere continued to be the region of greatest frequency of spot groups during the month.

October, 1896. Sun-spots during the first half of October were very few, no spots being seen on the 5th. From the 18th to the close of the month, several small groups made the transit of the disc. The southern hemisphere continues to be the location of greatest spot frequency.

November, 1896. Sun-spots during the month of November, 1896, were few and small, with the exception of a fairly large and interesting group, which made the transit of the disc from about the 2d to 14th, but of which only a few observations could be obtained, owing to the cloudy weather. As in the preceding six months, the southern hemisphere still continues to be the region of maximum spot frequency.

December, 1896. During the first half of the month of December, 1896, sun-spots were few and unimportant. During the latter half of the month, one group rapidly increased in size and made the transit of the disc, but was on the wane before disappearance at the west limb. The southern hemisphere still continues to be the predominant region of spot disturbances.

Notwithstanding the fact that during the year 1896 the period of minimum of solar activity had set in, several very large and unusually fine groups of spots appeared during the year. A brief description of some of these is given here. A reference number is given to every group each month.

FEBRUARY, 1896.—GROUPS NOS. 11, 14, 15.

February 20. No 11: a small single spot with penumbra near west limb; this was an interesting group, first appeared on 10th at east limb as a couple of small spots, soon enlarged, and was quite conspicuous from 14th to 18th, undergoing many changes from day to day, and passing over the west limb as a small spot again. No. 14: a quite prominent group, three large spots. No. 15: a new, fine, large group on east limb, about twenty degrees south of equator; it consists of a large penumbra, with double nucleus, the nuclei being connected by a narrow line of umbra; the nucleus on west side is crossed by a "bridge"; many faculæ surround the group, and many small spots are in its vicinity.

February 21. No. 14: a train of large spots, with two large leader spots. No. 15: a very fine, large group, still having the nuclei connected by a narrow dark line.

February 23. No. 14: this group is a superb object; it is fully one-tenth of the apparent diameter of the Sun in length, and consists of three fine large spots. Each of the first two spots contains double nuclei, and a "bridge" was noticed crossing a portion of the umbra of the second spot. No. 15 is also a very interesting and superb group; the large leader spot has triangular umbra in nearly round penumbra; this is followed by a larger, somewhat rectangular penumbra containing a series of small spots; many small spots and penumbral matter are also in vicinity. A group of four fine prominences was observed on west limb; one large banyan-tree-like form was quite interesting.

February 24. No. 14: still a fine object; umbræ of both leader spots greatly changed. No. 15: umbra of leader spot also much changed.

February 25. No. 14: about same; umbra of leader spot is getting large. No. 15 is more extensive; is now about on the central meridian; multitude of small spots in its vicinity.

February 26. No. 14: the umbra of the leader spot is still enlarging, and now crossed in center by a narrow "bridge"; this group is yet a fine object. No. 15 also contains a most interesting group; the nucleus of the leader spot is nearly round, and that of the next spot long and narrow, while the third spot contains a somewhat crescent-form nucleus.

MARCH, 1896.—GROUP NO. 21.

March 26. No. 21: a new group of two fine large spots, each with well-developed nucleus and penumbra; the west spot has three nuclei, the east, one with an elongated nucleus. A very extensive facula region appeared by rotation at the east limb.

March 30. No. 21 is now a little east of meridian, and is a little smaller; the leader, or west spot, has extensive penumbra, with one large nucleus and numerous small nuclei; the following spot has divided into two distinct spots, each with penumbra.

APRIL, 1896.—GROUP NO. 8.

April 10. No. 8: this is probably No. 6; it has changed decidedly since last observation. It is a very fine group in the northwest quadrant,

consisting of a large penumbral area, containing a double umbra; a small spot is on following side, its nucleus being crossed by a "bridge": many small spots are in its vicinity. A "veiled" group was noticed a little east of the central meridian, in south latitude.

MAY, 1896.—GROUP NO. 12.

May 26. No. 12: new group of many small spots, which formed since yesterday, little south of equator, about three days from east limb, with slight penumbra around two spots. No. 13: new small spot, east limb.

May 28. No. 12: great activity in this group; it now has a large oval penumbra, with one large and several smaller nuclei; this is followed in immediate vicinity by a number of small spots, some with slight penumbra.

May 29. No. 12 is a fine, much more extensive group to-day. The penumbral area is increasing, but breaking up somewhat; the main nucleus is larger and elongated; a large number of small spots, some with penumbra, are following this group. Much solar disturbance is manifest.

May 30. No. 12 is still a fine group; the nuclei seem to be coalescing; much penumbra surrounds and follows the group.

JUNE, 1896.—GROUPS NOS. 11, 12.

June 24. No. 11: on the central meridian to-day, is increasing much in activity; the leader spot has umbra which appears to be dividing; this is followed by a large area of penumbra and numerous small spots. No. 12: a new group in southwest quadrant, very extensive, containing a large leader spot and followed by many small spots.

June 25. No. 11: new small spots appearing on east side of group. No. 12: about the same as on yesterday, except not as many small spots in vicinity.

June 26. No. 11: the group is breaking up, the leader spot has divided into two parts, each with penumbra; a "bridge" is across the umbra of the large west spot. No. 12: the umbra of leader spot is oval; the penumbra does not entirely surround it, apparently being overlaid by facula on its east side.

June 27. No. 11 is fast diminishing in size and breaking up. No. 12: the leader spot is now on edge of west limb; its nucleus has penumbra on north and south, but not on east or west sides.

June 28. No. 11: only a few spots left, with a trace of penumbra. No. 12: but a dot left on extreme edge of west limb; group disappearing by solar rotation. Very fine prominence was observed on southeast limb at 1:20 P.M.; portions of it attained a high altitude, but at 2:20 P.M. had greatly changed, and at 3:25 P.M. no floating cloud forms were seen, and prominence was more quiescent; also prominences on west limb, one of which was pyramidal in form.

JULY, 1896.—GROUP NO. 12.

July 12. No. 12: fine new spot with double umbra on edge of southeast limb, penumbra partially visible on west edge of lower

nucleus, but not on west edge of upper one, and is visible on all other sides of both nuclei. A fine aurora last evening. A bright group of prominences was directly over the group on limb.

AUGUST, 1896.—GROUP NO. 13.

August 30. No. 13: a new group on east limb, with two nuclei in large facula. A very fine group of prominences was observed on the west limb at 3 P.M., also smaller one on east limb.

SEPTEMBER, 1896.—GROUP NO. 6.

September 11. No. 6: a very fine train of spots well in, on east limb in north latitude; about fifteen nuclei were counted in the extended penumbra; several portions are detached and of a semi-circular form; the group is inclined about fifteen degrees, or more, toward the equator.

September 13. No. 6: this is a magnificent group to-day; it has greatly increased in size, length and interest; fully thirty nuclei are included in the long detached groups of penumbral nebulosity which still has the semi-circular form in numerous portions.

September 16. No. 6: this great group is almost exactly bisected by the central meridian to-day; several transits of the group were taken to estimate its length, which was found to be about 190,000 miles.

September 17. No. 6: the fine group continues about the same, but segmentation of the spots has set in.

September 19. No. 6: the group is breaking up somewhat; the following spots are thinning and fading out.

September 20. No. 6 is now breaking up; it has two irregular penumbral areas, one with a large nucleus and the other containing two nuclei; the smaller spots are fading out.

September 22. No. 6: but a couple of small spots left of this group which is disappearing by solar rotation.

OCTOBER, 1896.—GROUP NO. 16.

October 23. No. 16: a spot on extreme edge of east limb, south of equator, near which place, at 11:55 A.M. to 12:30 P.M., an intensely brilliant small prominence was observed; a detailed account of this phenomenon was published in *Popular Astronomy* for December, 1896.

October 24. No. 16: a well-defined, medium-sized spot, with penumbra, which is not visible on west side of umbra yet.

October 25. A very fine group of prominences on west limb; one large, feather-like prominence and several smaller ones; the larger one was fully 90,000 miles in height. See my account of it in *Popular Astronomy* for December, 1896.

NOVEMBER, 1896.—GROUP NO. 3.

November 4. No. 3: fine, large spot, one day in, on east limb in south latitude; has a nearly circular penumbra with umbra, the umbra being divided by a semi-circular streak of light.

November 5. No. 3: only a faint streak of light crossing umbra to-day.

November 11. No. 3 is now in southwest quadrant. Cloudy weather prevented any observations of this fine spot since the 5th; the umbra is somewhat oval, and the entire spot larger.

November 12. No. 3: the umbra is more "triangular" in form to-day.

November 13. No. 3: penumbra is not visible on west edge of umbra to-day.

November 14. No. 3: this fine spot is now on edge of west limb; the penumbra is not apparent on either east or west edges of its umbra.

DECEMBER, 1896.—GROUPS NOS. 8, 15.

December 15. No. 8: group of about fifteen small spots a little east of meridian, several having penumbra.

December 18. No. 8 is larger, and consists of five or six spots, with penumbra, some with several nuclei.

December 19. No. 8: three spots have three or more nuclei each; No. 15: minute spots northeast.

December 22. No. 8 is now disappearing at west limb by solar rotation. No. 15 has developed into a fairly large group; has one fine leader-spot, with broken umbra in a somewhat circular penumbra, and followed by a compact group of small spots.

The following table gives the maximum and minimum number of sun-spot groups observed on any day for the months and years indicated:—

Months.	Maximum Daily Number of Sun-spot Groups.		Minimum Daily Number of Sun-spot Groups.	
	1895.	1896.	1895.	1896.
January	..	6	..	1
February	..	6	..	1
March	..	5	..	1
April	..	7	..	0
May	..	4	..	1
June	..	5	..	2
July	..	9	..	1
August	8	5	2	0
September	9	6	2	1
October	8	6	2	0
November	6	6	1	2
December	11	8	1	2

ALTA, Iowa.—Latitude 42° 40′ N.
Longitude $6^h\ 21^m$ W.

PREDICTIONS FOR THE SOLAR ECLIPSE OF JULY 29, 1897, LICK OBSERVATORY AND SAN FRANCISCO.

By C. D. Perrine.

The eclipse of July 29, 1897, which is visible in the tropics as an annular eclipse, is visible in the United States as a partial one. I have computed the following circumstances for the Lick Observatory and San Francisco—the Davidson Observatory—from the elements of the eclipse given by the *American Ephemeris*, taking into account the altitude in the computations for the Lick Observatory. The altitude in this case has nearly the maximum effect at the time of first contact, and makes a difference of about 1.5 seconds.

Prediction for Lick Observatory.

Eclipse begins	$5^h\ 25^m\ 1^s$ A.M., P. S. T.
Greatest obscuration	6 14 44
Eclipse ends	7 9 21
Amount of greatest obscuration	0.387 of solar diameter.
Position-angle of beginning	$246^\circ\ 37'$
Position-angle of ending	140 15

Prediction for Davidson Observatory, San Francisco.

Eclipse begins	$5^h\ 26^m\ 23^s$ A.M., P. S. T.
Greatest obscuration	6 15 21
Eclipse ends	7 8 27
Amount of greatest obscuration	0.386
Position-angle of beginning	$245^\circ\ 19'$
Position-angle of ending	141 30

(Position-angles are reckoned from the north point through the east.)

February 19, 1897.

MAXIMUM OF o *Ceti* (Mira), 1896–97.

BY MISS ROSE O'HALLORAN.

In the following observations a record of minute grada of lustre has not been attempted, but merely a careful outli the distinct changes, relatively to the comparison stars during the intervals of clear weather.

Sept. 25, midnight. Not more than one magnitude bri than companion, 110″ distant; in the moonlight in tint.

26, 1:30 A.M. Ditto; seen near meridian.

Oct. 11. More than one magnitude brighter than companic

20. Ditto; noticeably reddish.

27. Ditto.

28. Visible in opera glass of mean power.

Nov. 11. Equal to 71 *Ceti*, about 2° to the east.

13. Ditto.

24. Visible to the naked eye; equal to 70 *Ceti*; degrees to the north.

25. Ditto.

28 and 29. Brighter than 66 *Ceti*, 1½° to the northwe

Dec. 2. About as bright as ξ *Piscium*.

5. Brighter than ξ *Piscium*.

6. Ditto.

7. About one magnitude less than δ *Ceti*.

8. Somewhat brighter than before.

19. Equal to δ *Ceti*.

21. Brighter than δ.

24. Ditto; not as bright as γ *Ceti*.

30 and 31. Equal to δ.

Jan. 1 and 2. Ditto.

5, 6, 7, 8. Less than δ.

9. Brighter than δ; perhaps owing to moonlight.

14. About equal to δ.

Jan. 15. Fainter than δ, even in the moonlight.

17. Fainter than δ.

22, 23, 25. Ditto.

Feb. 1. Ditto.

7. About half a magnitude fainter than δ.

21. Equal to ξ *Piscium.*

22. Ditto.

23. Not so bright as ξ *Piscium.*

24. Ditto; brighter than 70 *Ceti.*

25, 26, 27. Ditto.

Mar. 1, 2, 4, 5, 8, 9, 10. Ditto.

11 and 12. Doubtful.

18. Fainter than 70 *Ceti.*

20. Ditto. In opera glass about equal to 66 *Ceti.*

No satisfactory comparisons could be made after this date, though the variable was observed until March 25th.

San Francisco.

W. C. BOND.

NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

PHOTOGRAPHS OF DONATI'S COMET IN SEPTEMBER, 1858.

A letter from Professor G. P. BOND to Mr. R. C. CARRING-ɔN, dated April 4, 1859, states that a photograph of DONATI's ›met was obtained at the Harvard College Observatory on ɘptember 28, 1858. The exposure was 6^m, and the plate ıowed the nucleus and a little nebulosity, fifteen seconds in ameter. (*Annals* H. C. O., Vol. III, p. 210.) In his reply of ay 26th, Mr. CARRINGTON sends another photograph of the ›met to BOND, taken on September 27th by ? ? ? with an ;posure of seven seconds, using a camera lens (I infer that it as a portrait lens of some five inches in aperture), which shows uch more nebulosity. CARRINGTON's enclosed photograph is ɔt now to be found, I believe. The photograph was unknown to 'r. DE LA RUE, apparently (see *Monthly Notices*, R. A. S., ol. XIX, p. 353). Both these photographs—the first ever made ; comets—have remained unnoticed by all the historians of ;tronomical photography, up to this time, so far as I know.

E. S. H.

EARCH FOR COMET, OR COMETS, REPORTED BY DR. SWIFT, SEPTEMBER 20TH.

On September 21, 1896, a telegram from Dr. SWIFT was ɘceived here as follows: "Last night, at sunset, object as bright s *Venus* one degree east of Sun."

That afternoon, with a HERSCHEL prism applied to the twelve-ıch telescope, I examined the region immediately about the 'un, and then with a low-power eye-piece, for several degrees on

* Lick Astronomical Department of the University of California.

every side of the Sun, without finding the object. As the Sun set, I again searched north, south, and east of it, and the next morning as it arose, north, south, and west of it, without success.

For several mornings and evenings Mr. PERRINE searched with the comet-seeker the region for many degrees about the Sun.

W. J. HUSSEY.

BRIGHT FIRE-BALL, JANUARY 26, 1897 (MT. HAMILTON).

At $0^h\ 11^m\ 44^s$ A.M., P.S.T., a brilliant fire-ball fell slowly from *Orion*, almost vertically — inclining a little towards the south. It burst into several pieces just before disappearing, but left no persistent train. It presented quite a sensible disc, and was several times as bright as *Venus* at her brightest — lighting up the sky noticeably.

C. D. P.

THE METRIC SYSTEM.

"President KELLOGG submitted the following: A communication urging active measures to secure the adoption of the metric system. Professor GEORGE DAVIDSON asks the signatures of our Regents and Faculty in its favor. Regent HOUGHTON offered the following resolution:

Resolved, That the Board of Regents of the University of California fully indorse and recommend the passage of the bill now before Congress to adopt the metric system of weights and measurements, as provided in H. R. 7251 of 1st Session of 54th Congress." [Adopted April 14, 1896.]—*Report of the Secretary of the University of California, 1895–6.*

ERRATUM IN NO. 53 OF THE *PUBLICATIONS*, A. S. P.

In the *Publications*, Volume VIII, page 328, line — 13, *for* AUWERS *read* AMBRONN, or ANDING.

(A. A.)

HOËNÉ WRONSKI.

Most readers of mathematical astronomy have at some time in their lives met with a paper by VILLARCEAU: *Mécanique Céleste; Exposé des Methodes de WRONSKI.* Attracted by the name of VILLARCEAU, they may have spent more or less time over it; but finally all must have left it, uncertain whether the unknown WRONSKI was "a charlatan, a madman, or a genius." At rare intervals the name of WRONSKI would recur to the

memory, accompanied by the uneasy feeling that the remaining doubt in his regard had not yet been settled. M. J. BERTRAND, Perpetual Secretary of the Paris Academy of Sciences, has lately taken a review of the whole of WRONSKI'S work,* and makes it very clear that he was neither genius nor charlatan, but simply insane. "His madness explains his charlatanism, excuses his imposture, and permits one to believe in the presence of genius imprisoned in insanity." After reading M. BERTRAND'S paper, few will doubt his conclusions. E. S. H.

PORTRAIT OF WILLIAM CRANCH BOND (DIRECTOR OF THE HARVARD COLLEGE OBSERVATORY, 1840–1859).

The portrait of Professor W. C. BOND given in this number is reproduced from a photograph of the oil painting now in the Harvard College Observatory. It forms one of the illustrations of a life of BOND,† which will shortly be printed; and is presented to the A. S. P. by the undersigned.

EDWARD S. HOLDEN.

MT. HAMILTON, February 28, 1897.

METEOR OF JANUARY 24, 1897 (LOS ANGELES).

LOS ANGELES, Cal., March 5, 1897.

Professor HOLDEN,

Lick Observatory, Mt. Hamilton, Cal.

Dear Sir:—On January 24th, at about 3:15 P.M., I observed a very large meteor, which passed over this place and, as near as I am able to judge, in a direction nearly due east. Unfortunately, I did not note the exact time of its appearance, and am not able to state the time positively, though from other circumstances, I am able to locate it as being about the time mentioned above. The meteor was visible sufficiently long for me to make a good observation of it. Its movement was, as before stated, nearly due east. Its apparent height was about thirty degrees above the horizon when first observed. At its disappearance it was approximately twenty-three degrees to twenty-five degrees above the horizon. Its color was a dazzling white, with a faint tinge of

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* *Revue des Deux Mondes*, Vol. 139, p. 588.

† Memorials of WILLIAM CRANCH BOND, Director of the Harvard College Observatory, 1840-59, and of GEORGE PHILLIPS BOND, Director of the Harvard College Observatory, 1859-65, by EDWARD S. HOLDEN.

blue. No train of smoke or fire followed, excepting a sheet of flame, giving the meteorite an elongated appearance. I should be pleased if you would forward me any notices you may have from other sources where this meteor has been observed, and greatly oblige, Yours very truly,

S. J. REESE.

MR. LOWELL'S OBSERVATIONS OF *MERCURY* AND *VENUS*.

The *Monthly Notices* of the Royal Astronomical Society for January, 1897, contains plates of drawings of *Mercury* and *Venus*, made by Mr. LOWELL at the Flagstaff Observatory in 1896. The markings on *Mercury* were "at once conspicuous" with the new twenty-four-inch object-glass; those on *Venus* are "perfectly distinct and unmistakable." The undersigned has made a considerable number of observations of *Mercury* in the years 1873-1885, and a very large number of *Venus* in the years 1873-1890, with telescopes of six, sixteen, twenty-six, thirty-six inches in aperture, without ever once seeing markings of the character depicted by Mr. LOWELL. Other markings of the class drawn by SCHIAPARELLI and many other observers, have, on the other hand, been seen and recorded whenever the conditions of vision were good. I have no hesitation in saying that such markings as are shown by Mr. LOWELL did not exist on *Venus* before 1890. It is my opinion that they do not now exist on the planet, but that they are illusions of some sort. Their general character * is what would be shown if the adjusting screws of an objective were set up too tightly, producing a set of strains in the glass, or if the objective were strained by its cell. Strains of this sort will produce faint companions to stars sufficiently bright. A comparison of all the drawings of *Venus* available in the library of the Lick Observatory is very instructive. All observers, except those at Flagstaff, see faint markings of one class; while those drawn by Mr. LOWELL are of a totally different nature.

Venus has been observed on very many occasions at Mt. Hamilton, with our essentially perfect twelve-inch object-glass, in the years 1888-1897, without once seeing markings of the kind drawn by Mr. LOWELL, or "distinct" markings of any kind. Faint and indistinct markings, of the character of those drawn by scores of observers for a century past, are, however, seen when the circumstances are good.

* Six or more radial rays, thicker at the outer rim of the image of the planet.

The foregoing notes seem to me to throw doubt on the reality of the markings reported from the Flagstaff Observatory. Until Mr. LOWELL's observations are fully confirmed by other observers with other telescopes, it will be wise not to accept them unreservedly. EDWARD S. HOLDEN.

MT. HAMILTON, March 9, 1897.

MEASURES OF β *DELPHINI*, β 151.

Date.	*p*.	*s*.
1896.828	350°.9	0″.45
.839	351 .8	0 .50
.877	354 .4	0 .53
1896.85	352°.4	0″.49

These measures were made with the 36-inch telescope, using powers of 1000 and 1500. On each night the star was close to the meridian, and the seeing was good. No third star was seen, though carefully looked for on each night with powers from 350 to 1500. R. G. AITKEN.

MT. HAMILTON, March 24, 1897.

FIRST RESULTS FROM THE BRUCE PHOTOGRAPHIC TELESCOPE AT AREQUIPA.*

The Harvard College Observatory *Circular*, No. 15, (December 30, 1896,) is devoted to the BRUCE photographic telescope (now in use by Professor BAILEY at Arequipa), and accompanied by three maps showing the splendid results which this telescope will give. It is essentially a huge portrait lens (doublet) of twenty-four inches aperture and 135 inches focus. These dimensions give stellar maps on a scale of 1′ = 1 *mm*. This scale has the advantage of being the same as that of the seventy-two charts made visually by CHACORNAC at Paris, and of the twenty charts made in the same manner by PETERS at Clinton.† The International Stellar Charts are made with telescopes of 0.33 *m*. (13.4 inches) aperture, and 3.43 *m*. (134 inches) focal length. Their scale is therefore essentially the same, but they are subject to a material disadvantage in comparison with the BRUCE telescope. The field covered by the International telescopes is about four

*See *Publications* A. S. P., Vol. V., pp. 82 and 186.

†The focal length which will give 1′ = 1 *mm*. is 3.438 *m*.

square degrees, whereas the BRUCE telescope (a doublet) covers about twenty-five square degrees (14 x 17 plates are used). The exposures for a given magnitude are materially shorter for the latter instrument. These advantages have been pointed out by Professor PICKERING at various times and places in the years 1883–87. In 1889, Miss CATHERINE W. BRUCE, of New York, generously provided the means to carry out the suggestion of Professor PICKERING. Mr. ALVAN G. CLARK undertook the very difficult task of making the objective, and in 1896 the complete telescope was mounted at Arequipa.* The maps accompanying the H. C. O. *Circular* are wonderfully fine, and show that the plan adopted for this powerful instrument has been completely successful. The BRUCE telescope is provided with an objective prism for photographing stellar spectra; and the preliminary results with this, also, are entirely satisfactory. It appears that Professor PICKERING has abandoned his original scheme of making a complete photographic map of the whole sky with this instrument, and intends to leave the map to the International Photographic Congress. The BRUCE telescope is to be employed, at least for the present, on maps of special regions and upon spectrum photography.

Miss BRUCE and the Harvard College Observatory are to be congratulated upon the splendid success of a daring experiment.

E. S. H.

ELEMENTS OF DESCRIPTIVE ASTRONOMY: A TEXT-BOOK. By Dr. HERBERT A. HOWE, Director of the Chamberlin Observatory, Denver. Boston: Silver, Burdett & Co., 1897, 8vo, pp. 340, with 195 colored, and other, plates and figures, star-maps, etc., etc.

[Reviewed by EDWARD S. HOLDEN.]

There is always room for a good text-book of descriptive astronomy, and the present volume will be welcomed by teachers in high-chools, and by those who wish to give a general course to college students without going into the more technical details of the subject, while insisting on a full treatment of principles and an accurate account of the present state of knowledge.

Professor HOWE has, as might be anticipated, furnished a text

* A *pair* of telescopic doublets of 16 inches aperture is now being made by Mr. BRASHEAR for Professor MAX WOLF at Heidelberg. See *Publications* A. S. P., Vol. VII., p. 285.

embodying the most approved methods of teaching, as well as the most recent conclusions and findings of astronomers. His successful experience as a teacher of astronomy is manifest, not only in the plan of the book and the logical way in which it is developed, but also in his apprehension of the student's difficulties, and the helps over hard places which he affords. The many illustrations have been carefully chosen with a view to throwing light upon all phases of the subject. In typography, etc., the book is very successful.

The book is not without interest to the professional astronomer, also, as it brings the history of each subject down to the present time. With regard to the canals of *Mars*, for example, about which so much nonsense has been written, what summing up could be more happy than the following? "The majority of astronomers, while freely admitting the existence of the markings called canals, are inclined to be conservative with reference to any explanation of their nature. It has been aptly said, that it is better not to know so much, than to know so many things that are not so."

MT. HAMILTON, March 10, 1897.

PORTRAITS OF ASTRONOMERS AND OTHERS BELONGING TO THE LICK OBSERVATORY.

The Lick Observatory possesses a large number of portraits of astronomers and others, most of which are preserved in albums. Some of the larger photographs and engravings are framed and exhibited in the long hall of the Observatory or in the library room — ADAMS, AIRY, BAILLY, BRADLEY, BESSEL, BOND, BOWDITCH, CAYLEY, CHAUVENET, the CLARKS, the DRAPERS, GALILEO, GAUSS, GOULD, HELMHOLTZ, the HERSCHELS, KELVIN, KEPLER, KRONECKER, LICK, MAXWELL, MICHELSON, NEWCOMB, NEWTON, RUTHERFURD, STOKES, STRUVE, SYLVESTER, and others.

Portraits of the Regents and other officials of the University of California are included in the collection.

The photographs are derived from various sources: first, from gifts to the Observatory from many living astronomers, in answer to a circular of request; second, from a large collection presented by the undersigned; third, from miscellaneous sources.

The thanks of the Observatory are returned to all those who

have contributed to our collections; and if any of our frien can make our collections more complete, we shall be grea indebted.

Following is a list of all separate portraits on hand in Marc 1897. Beside these, many others are available in books cc tained in the library. It is hoped to print a list of the latter some future time.

EDWARD S. HOLDEN.

Abbe, C.
Adams, J. C. 3.
Airy, Sir G. B. 2.
Aitken, R. G.
Albrecht, Th.
Alvord, W.
Angot, A.
Anguiano, A.
Arago, F. 2.
Argelander, F.
Ashburner, W.
v. Asten, E.
Astrand, J. J.
Auwers, A. 2.
Bache, A. D.
Backlund, O.
Bailly, S. 2.
Bakhuysen, H. G.
Ball, Sir R. S.
Bardwell, Miss E. M.
Barnard, E. E. 3.
Bartlett, W. H. C.
Bass, E.
Bauschinger, J.
Becker, E.
Bessel, F. W. 2.
Bessels, E.
Bey, Ali.
Bischoffsheim, R. L.
Bohlin, K.
Bond, W. C. 2.
Bossert, J.
Bowditch, N. 2.
Boutelle, C. A.
Bradley, J. 2.
Brashear, J. A.
Bremiker, C.
Brendel, M.
Brooks, W. R.
Brown, Miss E.
Bruhns, C. 2.
Bruns, H.
Brünnow, F. F.
Budd, J. H.
Bull, S.
Bunsen, R. W.
Burckhalter, C.
Cacciatore, G.
Campbell, W. W. 2.
Cayley, A.
Chandler, S. C.
Charroppin, C. M.
Chauvenet, W. 2.
Christie, W. H. M.
Clark, A. 3.
Clark, A. G. 4.
Clark, G. B. 4.
Clausius, R. J. E.
Clerke, Miss A. M.
Coffin, J. H. C.
Colton, A. L.
Common, A. A.
Comstock, G. C.
Condorcet, M.
Cook, J. (Capt.)
Copernicus, N. 2.
Crew, H.
Crocker, C. F.
Crossley, E.
Curley, J.
Dana, J. D.
Davidson, G.
Davis, H. S.
Delambre, J. B. J.
Delmas, D. M.
Dembowski, E.
Doberck, W.
Dolland, J.
Donati, G.
Downing, A. M. W.
Draper, Mrs. A. P.
Draper, H. 2.
Draper, J. W. 2.
Dreyer, J. L. E.
Dubiago, D. T.
Dunér, N. C.
Eastman, J. R.
Easton, C.
Ebert, H.
Elger, T. G.
Elkin, W. L.
v. Engelhardt, B.
Engstrom, F.
Ennis, J.
Euler, L. 2.
Ewing, J. A.
Fabry, L.
Faraday, M.
Fergola, E.
Fernandez, L.
Flammarion, C.
Flamsteed, J.
Fleming, Mrs. M.
Floyd, R. S.
Foerster, W.
Fraser, T. E
Frear, H. P.
Friend, C. W.
Fritsche, H.
Frost, E. B.
Galileo, G. 2.
Gaudibert, C. M.
Galle, J. G.
Gauss, C. F.
Geelmuyden, H.
Gibbs, W.
Gill, D.
Gilliss, J. M.
Glasenapp, S.
Gould, B. A. 3.

Grubb, Sir H.
Gyldén, H. 2.
Hagen, J. G.
Hall, A., Sr.
Hall, A., Jr.
Hallidie, A. S.
Hamilton, L.
Hansen, P. A. 2.
Hansteen, C.
Harkness, W. 2.
Harrington, M. W.
Harzer, P.
Hazen, H. A.
Hasselberg, B.
Heis, E.
Hell, Father M.
Helmholtz, H. L. F. 2.
Henry, J.
Herschel, Miss Caroline
Herschel, Col. John
Herschel, Sir J. F. W. 2.
Herschel, Sir W. 3.
Hilgard, J. E.
Holden, E. S. 4.
Hough, G. W. 2.
Houghton, J. F.
Howe, H. A.
Hubbard, J. S.
Huggins, W. 2.
Hussey, W. J.
Ivanhof, A.
Janssen, J. 2.
Kaiser, F.
Kayser, H.
Keeler, J. E.
Kellogg, M.
Kelvin, Lord 2.
Kempf, P.
Kepler, J. 3.
v. Kirchhoff, G. R.
Kirkwood, D.
Klinkerfues, W.
Klumpke, Miss D.
Knobel, E. B. 2.
v. Konkoly, N.
Kreuger, A. 2.
Kreutz, H.
Kronecker, L.
de Lalande, J. G. L.
v. Lamont, J.
Lamp, E.
Lang, A., Santa Cruz, W. I.
Langley, S. P. 3.
Lassell, W. 2.
Law, W. W.
Leadbetter, C.
Leavenworth, F. P.
Le Conte, John 2.
Lehmann-Filhés, R.
v. Leibnitz, G. W.
Leuschner, A. O.
Le Verrier, U. J.
Lewis, H. C.
Lick, J. 6.
Lick, J. H.
Lindemann, E.
Lockyer, J. N.
Loewy, M.
Lorenzoni, G.
Lovell, J. R.
Lowell, P.
Luther, R.
Lyman, C. A.
Macfarlane, A.
Manson, M.
Marcuse, A.
Marth, A.
Martin, E. S.
Marye, G. T.
Mathews, H. E.
Maunder, E. W.
Maury, M. F. 2.
Maw, W. H.
Maxwell, J. C.
McLaren, Lord
Mendenhall, T. C.
Mendizibal-Tamborrel J.
Messer, J.
Meyer, M. W.
Michelson, A. A.
Mills, D. O.
Mitchell, Miss Maria
Mizzi, L. F.
Molera, E. J.
Möller, A.
Monck, W. H. S.
Monge, G. 2.
Morrison, J.
Murphy, B. D.
Negus, J. D.
Negus, T. S.
Newcomb, S. 2.
Newton, H. A. 2.
Newton, Sir I. 4.
Nielsen, V.
Nightingale, J.
Nobile, A. 2.
Noble, W.
Norton, W. A.
Nyren, M.
Olbers, W.
Oom, F. A.
Oppenheim, H.
v. Oppolzer, E.
v. Oppolzer, Th.
Oriani, B.
Otis, J.
Palisa, J. 2.
Parkhurst, J. A.
Paul, H. M.
Pechüle, C. F.
Peirce, B.
Peter, B.
Peters, C. A. F.
Peters, C. F. W. 2.
Piazzi, G.
Pickering, E. C.
Pickering, W. H.
Pihl, O. A. L.
Plum, C. M.
Pontécoulant, Comte.
Poor, C. L.
Preston, E. D.
Prince, C. L.
Pritchett, C. W.
Pritchett, H. S.
Proctor, R. A.
Raymond, W. G.
Rees, J. K.
Repsold, J. A.
Repsold, O.
Ricco, A.
Ristenpart, F.
Roberts, I.
Rodgers, A.
Rodgers, J.

Rogers, W. A. 2.
Rosén, P. G.
Rosse, Lord
Rotch, A. L.
Rowland, H. A.
Runge, C.
Runkle, J. D.
Rutherfurd, L. M. 4.
Sabine, E.
Salazar, L.
de Saussure, H. B.
Sawyer, E. F.
Schaeberle, J. M. 4.
Schiaparelli, J. V.
Schorr, R.
Schott, C. A.
Schulhoff, L.
Schultz, H.
Schumacher, R.
Schumann, V.
Schur, W.
Schuster, A.
v. Schweiger-Lerchenfeld, A.
Scott, I.
Seares, F. H.
Searle, A.
Searle, G. M.
Secchi, Father A.
See, T. J. J.
Seeliger, H.
Seidel, L.
Sestini, A.
Siemens, Sir C. W.
Skinner, A. N.
Smith, H. L.
Snell, R.
Spencer, H.
Stackpole, W.
v. Steinheil, A. C.
St. John, C. M.
Stockwell, J. N.
Stokes, G. G.
Stone, O.
Struve, Otto. 2.
Struve, W. 2.
Swasey, A.
Swift, J. F.
Swift, L.
Sylvester, J. J.
Tacchini, P. 3.
Tait, P. G.
Taylor, I. M.
Terby, F.
Tesla, N.
Thome, J.
Tisserand, F. F.
Todd, D. P. 2.
Todd, S. E.
Trouvelot, L.
Tucker, R. H. 2.
Tycho Brahe.
Tyndall, J.
Updegraff, Mrs. A. L.
Upton, W.
Valle, F.
Van Hise, C. R.
Villarceau, L.
Violle, J.
Vogel, H. C.
Walker, S. C.
Warner, H. H.
Warner, W. B.
Waterman, R. W.
Watson, J. C.
Weinek, L. 3.
Wesley, W. H.
White, E. J.
Wiedemann, E.
Winlock, J.
Wislicenus, W. F.
Witkovsky, B.
Woeikof, A. J.
Wolf, C.
Wolf, Max
Wolf, R.
Wolfer, A.
Wolff, F. T.
Wright, T.
Yarnall, M.
Young, C. A.
Zenger, C. V.
Ziel, F. R.

Light Absorption as a Determining Factor in the Selection of the Size of the Objective for the Great Refractor of the Potsdam Observatory.

In the Transactions of the Royal Prussian Academy of Sciences, Professor Vogel gives, under the above title, an interesting and important article on the methods and results of experiments made to determine the loss of light in refracting telescopes through absorption by the glass of the objective. The research was undertaken, as the title suggests, to determine the size of the lenses for the new Potsdam refractor, with the result that 80 *cm.* was adopted as the size of the objective. This lens is corrected for the actinic rays, and will be mounted with a guiding telescope of 50 *cm.* aperture, corrected for visual rays.

No abstract of this article is here attempted, as a translation of the entire paper may be found in the *Astrophysical Journal* for February, 1897.

It is of interest, however, to note that, according to Professor VOGEL's tables, giving the intensity of the transmitted in terms of the incident light, as the thickness of the objective varies, the visual objective of the thirty-six-inch telescope of the Lick Observatory (thickness about 7¼ *cm.*) transmits about eighty-eight per cent. of the *visual* rays that fall upon it, if allowance is made for absorption only, and seventy-four per cent., allowing for absorption and reflection. When the photographic correcting lens is added, the thickness of the objective is approximately 12 *cm.*, and the intensity of the transmitted *actinic* rays, in terms of the incident, is sixty per cent. when absorption alone is considered, and forty-nine per cent. when absorption and reflection are both taken into account. R. G. AITKEN.

March 15, 1897.

AWARDS OF THE COMET-MEDAL OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.

The DONOHOE Comet-Medal has been awarded as follows, since its foundation:

1. W. R. BROOKS, March 19, 1890.
2. W. F. DENNING, July 23, 1890.
3. J. COGGIA, July 18, 1890.
4. R. SPITALER, November 16, 1890.
5. T. ZONA, November 15, 1890.
6. E. E. BARNARD, March 29, 1891.
7. E. E. BARNARD, October 3, 1891.
8. L. SWIFT, March 6, 1892.
9. W. F. DENNING, March 18, 1892.
10. W. R. BROOKS, August 28, 1892.
11. E. E. BARNARD, October 12, 1892.
12. E. HOLMES, November 6, 1892.
13. W. R. BROOKS, November 19, 1892.
14. W. R. BROOKS, October 16, 1893.
15. W. F. DENNING, March 26, 1894.
16. W. F. GALE, April 2, 1894.
17. J. M. SCHAEBERLE, April 16, 1893.
18. E. D. SWIFT, November 20, 1894.
19. L. SWIFT, August 20, 1895.
20. C. D. PERRINE, November 17, 1895.
21. W. R. BROOKS, November 21, 1895.
22. C. D. PERRINE, February 15, 1896.
23. L. SWIFT, April 13, 1896.
24. W. E. SPERRA, August 31, 1896.
25. E. GIACOBINI, September 4, 1896.
26. C. D. PERRINE, November 2, 1896.
27. C. D. PERRINE, December 8, 1896.

MEMORIALS OF WILLIAM CRANCH BOND, DIRECTOR OF THE HARVARD COLLEGE OBSERVATORY, 1840–59, AND OF HIS SON, GEORGE PHILLIPS BOND, DIRECTOR OF THE HARVARD COLLEGE OBSERVATORY, 1859–65, BY EDWARD S. HOLDEN, DIRECTOR OF THE LICK OBSERVATORY. 8VO. 1897. PUBLISHED AT THE COST OF THE DAUGHTERS OF GEORGE BOND, AND SOLD BY C. A. MURDOCK & CO., 532 CLAY STREET, SAN FRANCISCO, AND BY LEMCKE & BÜCHNER, 812 BROADWAY, NEW YORK CITY.

No adequate biography of either of the BONDS is available. At the request of the daughters of GEORGE BOND, I have undertaken to arrange the manuscript material in their hands in an orderly form. The book will be printed and published as above. The contents are: Chapter I, Life of W. C. BOND, 1789–1859; II, Life of G. P. BOND, 1825–1865; III, Selections from the Diaries of GEORGE BOND; IV, Selections from the Correspondence of GEORGE BOND; V, Account of the Scientific Work of the BONDS; Appendixes, giving a complete list of their published writings; and Index of Proper Names.

The book will be well illustrated. It is hoped by the kindness of Professor E. C. PICKERING, Director of the Harvard College Observatory, to reproduce two fine steel engravings of the Great Comet of 1858 and of the nebula of *Orion* from the plates of the *Annals* H. C. O. A small edition only will be issued. The price of a single copy, bound in cloth, including postage, will be two dollars. Orders may be sent to C. A. MURDOCK & Co., 532 Clay street, San Francisco, or to Messrs. LEMCKE & BÜCHNER, 812 Broadway, New York City.

EDWARD S. HOLDEN.

LICK OBSERVATORY, March 27, 1897.

THE REVERSING-LAYER OF THE SUN'S CORONA (TOTAL SOLAR ECLIPSE OF 1896, AUGUST 9).

A photograph of this eclipse, taken by Mr. SCHACKELTON, F. R. A. S., at Nova Zembla, shows the Sun's "reversing-layer" first observed by Professor YOUNG (visually) at the eclipse of 1870. The "reversing-layer" is, in a sense, the Sun's true atmosphere, and YOUNG's observation of 1870 seemed to show that it can hardly be more than 500 miles in thickness. Professor YOUNG's conclusions have been much called in question

Professor LOCKYER, whose dissociation theory requires a deep solar atmosphere, with a considerable range of temperature between its upper and lower levels. Mr. SHACKELTON'S photograph has been examined by Professor YOUNG, and fully bears out his conclusions. E. S. H.

GIFT OF MISS BRUCE TO THE OBSERVATORY OF PRAGUE.

"The Director of the Observatory of Prague, Professor L. WEINEK, has received from Miss CATHERINE W. BRUCE, the high-minded patroness and well-wisher of astronomy in America, the sum of 2439 florins ($1000) for the publication of the large photographic Moon-Atlas begun by him in 1893."—*Prager Abendblatt*, March 3, 1897.

MEASURES OF *SIRIUS*.

Both of the following measures were made with the thirty-six-inch telescope, using a 520-power eye-piece. *Sirius* was a few minutes east of the meridian each night, and the atmospheric conditions were fair.

Date.	*p*.	*s*.
1897.203	184.°9	3.″98
1897.206	185.°3	3.″92

R. G. AITKEN.

March 16, 1897.

LATITUDE OF THE LICK OBSERVATORY.

The mean value of the normal* latitude, ϕ_0, derived from observations with the meridian-circle in the interval between September, 1893, and June, 1896, is—

37° 20′ 25″.66 from about 1400 observations of 86 Berliner Jahrbuch equatorial stars;

37° 20′ 25″.47 from about 1000 observations of 45 Berliner Jahrbuch circumpolar stars; and

37° 20′ 25″.85 from 160 observations of 22 Berliner Jahrbuch zenith stars.

The correction for bisection and various systematic errors of observation should be largely eliminated from the mean of cir-

* Corrected for CHANDLER'S Variation.

cumpolar and equatorial results. The bisection correction is eliminated from the zenith determinations, made facing north and south alternately, for the same star.

Some of the B. J. declinations of zenith stars have undoubtedly large errors; the declinations of the *American Ephemeris* would reduce the observed latitude by $0''.23$ for sixteen of these stars. The normal latitude $\phi_0 = 37^\circ\ 20'\ 25''.6 -$ corresponding to the epoch 1895.1 may be adopted as the best value furnished by the series of observations made in this period.

R. H. TUCKER.

THE INTERNATIONAL ASTROGRAPHIC CHARTS.

"The fourth *réunion* of the Comité Permanent was held in Paris in May. The reports furnished by the Directors of the co-operating observatories show that satisfactory progress has been made in two-thirds of them. Owing to political or financial difficulties, the work has not yet begun at Santiago de Chili, La Plata, and Rio Janeiro, and is seriously hampered at several other observatories.

The following table shows how far the photo-mapping has advanced in the different zones:—

	Zone.	No. of Fields Assigned.	No. taken for Cat.	No. taken for Chart.	
Greenwich	+90 to +65	1149	728	472	213 plates measured; 102 pl[illegible] constants determined.
Rome	+64 to +55	1040	280	100	—
Catania	+54 to +47	1008	21	None.	—
Helsingfors	+46 to +40	1008	1008	A few.	160 plates measured a[illegible] partly reduced.
Potsdam	+39 to +32	1232	500	A few.	35,000 stars measured.
Oxford	+31 to +25	1180	800	None.	40,000 stars measured on 1[illegible] plates.
Paris	+24 to +18	1260	1155	Not stated.	318 plates measured, 60 reduced.
Bordeaux	+17 to +11	1260	300	60	Measures to be begun soon.
Toulouse	+10 to + 5	1080	150	350	70 plates measured.
Algiers	+ 4 to − 2	1260	1000	64	168 plates measured wit[illegible] 32,000 stars.
San Fernando	− 3 to − 9	1260	1260	About 400.	50 plates measured once an[illegible] 25 twice.
Tacubaya	−10 to −16	1260	529	Not stated.	Measuring to begin soon.
Santiago de Chili	−17 to −23	1260	—	—	—
La Plata	−24 to −31	1360	—	—	—
Rio Janeiro	−32 to −40	1375	—	—	—
Cape of Good Hope	−41 to −51	1512	1512	Nearly half.	30 plates measured.
Sydney	−52 to −64	1400	1303	1112	—
Melbourne	−65 to −90	1149	703	A few.	—

Examination of this table shows that (omitting altogether the three South American observatories which have not yet com-

menced) the taking of the catalogue plates is generally well advanced, and that some progress has been made with the chart-plates. The measurement and reduction of the catalogue plates have been begun by more than half the observatories, and considerable progress has been made by six or seven of them.

The Congress first turned its attention to the degree of accuracy which it was desirable to obtain in the measurement of the photographs. It was decided that the probable error of the measured co-ordinates ought not to exceed $\pm 0''.20$.

The choice of the reference-stars and the methods of measurement and reduction were left to the discretion of the Directors of the co-operating observatories. It was resolved that the measured rectilinear co-ordinates should be published as soon as possible, along with the necessary data for obtaining the Right Ascension and Declination of the stars when required. With regard to the magnitudes, the Congress laid down no conditions except that the methods adopted for their determination should be capable of precise definition, so that the scales employed at different observatories might be readily comparable. For the Chart, it was decided that in the odd zones a triple exposure of 30^m should be given.

Captain ABNEY undertook to supply the different observatories with scales which should be printed on the plates at the same time as the *réseau*, and supply a measure of the sensibility of the plates for light of different intensities. It was also resolved that two positives of each chart-plate should be made on glass, and that one of them should be placed in the *Bureau National des Poids et Mesures.*"—From *Monthly Notices* R. A. S., Vol. LVII, p. 298.

WEATHER AT MT. HAMILTON IN THE WINTER OF 1896–97.

The following data are taken from the meteorological records for the respective months, the record for March being included to date:—

	1896. Nov.	Dec.	1897. Jan.	Feb.	Mar.	Total.
Cloudy nights	14	17	10	18	15	74
Rainfall (including melted snow), in inches	5.8	4.9	3.5	5.9	0.6	20.7
Snowfall, in inches	1	3	2	17	30	53

During the first three of these months, the clear nights, and occasionally part of a night marked "cloudy," were suitable for

observing. A few nights were very good, but from January 25th to date there have been but fourteen clear nights, and not more than one-half that number on which the "seeing" could be called good.

R. G. AITKEN.

MT. HAMILTON, March 20, 1897.

THE COMPANION OF *SIRIUS*, OBSERVED AT GLASGOW, MISSOURI, WITH A TWELVE-INCH TELESCOPE.

[Extract of a letter from Professor H. S. PRITCHETT.]

"Saturday night, March 20, 1897, I was at Glasgow, and the night was unusually fine. I have seldom seen so good a one in this climate. With the 12½-inch glass, both my father and myself saw the *Sirius* companion (shutting the bright star out of the field). The result of three settings of the micrometer gave $p = 195°$; s (estimated) between $3''$ and $4''$."

THE BRUCE MEDAL OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.

It is the intention of Miss CATHERINE WOLFE BRUCE, to whom Astronomy in all parts of the world owes so many and such intelligent benefactions, to found and endow a gold medal, to be awarded not oftener than once a year by the Astronomical Society of the Pacific, "for distinguished services to Astronomy." It is Miss BRUCE's desire that the medal shall be international in character, and that it shall be awarded to citizens of any country, and to persons of either sex.

The medal is to be of gold, about sixty millimetres in diameter, and is to bear the seal of the Society on the *obverse.** The *reverse* is to bear an appropriate inscription. The formal offer of Miss BRUCE will be made, and the medal founded and endowed, during the present year, so that the first award can be made (if desirable) for the year 1898. At the proper time, due acknowledgments will be offered to Miss BRUCE for this very generous gift to Science and to the Society. Not only will the BRUCE medal tend to the advancement of Astronomy, and enable the Astronomical Society of the Pacific to adequately recognize scientific work of the highest class (and these are Miss BRUCE's only desires), but it will forever connect the name of

* See these *Publications*, Volume III, page 78, for a full-sized drawing of the seal.

the founder with the progressive advances of Astronomy. Those who are knowing to her very many and wise subventions of astronomical research (a few of which are spoken of in these *Publications*),* will welcome this, her latest gift, for personal as well as for scientific reasons. The Society is to be congratulated that Miss BRUCE has selected it as the Trustee to carry out her generous desires. If the trust is executed, as it will be, with intelligence, fidelity and circumspection, the time will soon come when the BRUCE medal will be one of the most highly-prized recognitions of original and useful service to Astronomical Science.

EDWARD S. HOLDEN.

THE LICK OBSERVATORY, April 6, 1897.

RETURN OF THE LOWELL OBSERVATORY TO ARIZONA.

"'The Lowell Observatory has not found the site in the vicinity of the City of Mexico as favorable as had been expected, and will be moved back to Flagstaff, Arizona."†—*Science*, March 26, 1897, page 512.

THE CAPE PHOTOGRAPHIC *DURCHMUSTERUNG*‡

In 1885, Dr. GILL commenced a photographic survey of the southern heavens from eighteen degrees of South Decl. to the south pole. The observations have been made at the Cape, and the measures and many of the reductions by Dr. KAPTEYN, in Holland. The negatives were made with a DALLMEYER lens of six inches aperture and fifty-four inches focus, and the exposures (thirty to sixty minutes) are chosen so as to include all stars as bright as the tenth magnitude. Each plate covers thirty-six square degrees. The epoch of the Catalogue is 1875.0; and the probable errors of the positions are $0^s.27$ and $2''.6$ in R. A. and Decl. respectively.

The (photographic) magnitudes are deduced so as to make the mean photographic magnitude of a group of stars identical with the mean visual magnitude. The average number of stars per square degree is 25.4, and the absolute number varies from

* Vol. II, p. 307; Vol. V, p. 82; Vol. V, p. 186; Vol. VIII, p. 243; Vol. IX, No. 55 (BRUCE Telescope, Moon maps, etc.)

† See *Mountain Observatories*, 1896, page 66.

‡ The first volume of this work (—19° to —37°), containing 152,000 stars, is printed. The second volume (—38° to 52°), containing 158,000 stars, is in the press.

six to more than one hundred. In ARGELANDER'S *Durchmusterung*, the average number is 15.2, in SCHOENFELD'S it is 18.5, and in the Cordoba D. M. ($-22°$ to $-42°$) it is 56.1.—Abstract of a paper in the *Monthly Notices* R. A. S., Vol. LVII, p. 297.

INTERNATIONAL CATALOGUE OF FUNDAMENTAL STARS.

In May, 1896, a Conference was held at Paris at the invitation of the *Bureau des Longitudes*, to consider a plan for the formation of a fundamental catalogue of standard stars for the ephemerides published in France, England, Germany, and America. The personnel of the Conference was Messrs. AUWERS (Germany), BACKLUND (Russia), BAUSCHINGER (Germany); CHRISTIE (England), DOWNING (England), GILL (Cape of Good Hope), LOEWY (France), NEWCOMB (United States), TISSERAND (France). M. FAYE (France) acted as President, and Messrs. v. d. S. BAKHUYSEN (Holland) and TRÉPIED (France) served as Secretaries. The conclusions of the Conference were adopted with practical unanimity. The most important were as follows: For the fundamental catalogue, the equinox should be determined solely from observations of the Sun, excluding those of *Mercury* and *Venus*. The equinox of Professor NEWCOMB'S system (N_1) in Vol. I of the *Astronomical Papers of the American Ephemeris* was adopted.* In view of the uncertainty that still exists with regard to the numerical value of the personal error depending on magnitude, which affects the R. A., it was decided that corrections for such errors should *not* be applied. But as the existence of such (small and systematic) errors is undoubted, the Conference considered that observatories should make researches to fix their amounts. Professor NEWCOMB was entrusted with the duty of fixing the values of the precessions to be employed. The Conference decided to adopt the following constants: Nutation, $9''.21$;† Aberration, $20''.47$;‡ Solar Parallax, $8''.80$.§ It was decided that in the reduction of mean places of stars to apparent, the term of short period in R. A. (f') depending on twice the Moon's longitude should be omitted for both polar and equatorial stars.

* Catalogue of 1098 stars.

† Dr. GILL'S determination = $9''.207 \pm 0''.003$.

‡ From the adopted solar-parallax and the NEWCOMB-MICHELSON value of the velocity of light there results $20''.467 \pm 0''.012$.

§ Dr. GILL'S determination (heliometer) $8''.802 \pm 0''.005$.

Professor NEWCOMB was entrusted with the duty of preparing a provisional fundamental catalogue, which is to be finished during 1896. This catalogue is to contain about 1000 fundamental stars. The Conference laid down various other principles on which the catalogue should be constructed which are not mentioned here. It also expressed the hope that a scheme of international co-operation might be established for the calculation of the perturbations and ephemerides of the minor planets (of which there are now more than 400). The opinion was also formally expressed that a first-class *reversible* meridian-instrument, suitable for fundamental work, should be erected at one of the southern observatories. The changes of astronomical constants, as recommended by the Conference, are to take effect in the ephemeris for 1901. "There appears to be every reason to expect that the catalogue will be ready in good time, and that astronomers may look forward to the inauguration of a new era in the history of astronomical ephemerides at the commencement of the twentieth century."—Abstract of a paper by Dr. DOWNING in the *Monthly Notices* R. A. S., Vol. LVII, page 299.

PROBABLE ERROR OF A SINGLE OBSERVED POSITION IN SOME FREQUENTLY USED CATALOGUES AND COLLECTIONS OF STARS.

The probable accidental error of an observed place, depending on a single observation, in the following catalogues, etc., is (approximately) as follows:—

	R. A. (Equator). s.	Decl. ″
Harvard College Observatory (Vol. XII)	.02	0.3
Berlin Observatory (670 stars)	.02	0.3
" Observatory (521 stars)	± 0.03	± 0.3
Lick Observatory (310 stars)	.03	0.3
Pulkowa Catalogue (Vol. VIII)	.03	0.3
" " (5634 stars)	.04	0.3
Washburn Observatory (303 stars)	.03	0.4
Yarnall's Catalogue	.03*	0.5*
Dunsink Observatory (717 stars)	.04	0.5
Harvard College Observatory (A. G. Zone)	.03	0.6
Dudley Observatory (A. G. Zone)	.04	0.6
Helsingfors-Gotha Observatory (A. G. Zone)	.06	0.6
Cincinnati Observatory (2000 stars)	.05	0.6
Bonn Observatory (Vol. VI; bright stars)	.04	0.6

	R. A. (Equator). s.	D[illegible]
Bonn Observatory (Vol. VI; stars 9th magnitude)	.06	[illegible]
" " (Vol. VI; stars 9.2 and 9.3)	.07	[illegible]
Grant's Glasgow Catalogue	.06	[illegible]
Cordoba Zone Catalogue	.06	[illegible]
Bond's Zones (H. C. O. Vol. II)	.07	[illegible]
Schjellerup's 10,000 stars	.08	[illegible]
Copeland and Borgen's Catalogue	.08	0.8
Wilson's 644 stars	.09	0.8
Dunsink Observatory (1600 stars)	.07	0.9
Armagh Observatory (Catalogue II)	.08	0.9
Lamont's Zones (re-reduced in Munich Annals, II)	.08	0.9
Harkness' Gilliss Southern Zones	.04	1.1
Weisse's Bessel's Zones, I	.16	1.4
Göttingen (Klinkerfues Schur, 6900 stars)	.10	1.4
Argelander's Southern Zones (Oeltzen)	.12	1.4
Weisse's Bessel's Zones, II	.15	1.6
Cincinnati Observatory (4050 stars)	.12	1.8
Cape (Photographic) *Durchmusterung*	.27*	2.6*
Lacaille (B. A. A. S.)	0.3*	8.7*
Section II, Bonn *Durchmusterung*	.38*	9.6*
Cordoba (visual) "	.42*	13.8*
Section I, Bonn "	.70*	25.6*

E. S. H.

ADDENDUM TO DR. MARTH'S ARTICLE ON PAGE 76.

	h. m. s.	° °	° °	"	[illegible]
1890, Aug. 24	7 38 5	26.71+1.45	—6.38+1.02	972.3	1
1891, July 14	9 33 29.5	16.40+1.15	—5.25—2.61	908.6	18
14	9 35 32.5	16.42+1.15	—5.26—2.60	908.6	18
1895, July 30	8 22 54	21.98+0.93	+6.69+7.51	929.4	10
31	9 16 49	34.63+0.91	+6.23+7.55	918.8	4
31	9 17 49	34.64+0.91	+6.23+7.55	918.8	4
Oct. 10	16 2 2.2	184.33—0.93	—5.35—5.36	966.2	6

NOTICE TO MEMBERS.

Owing to a misunderstanding, an essential part of the ma[illegible] script of the present number was not received until April 1[illegible] which accounts for the delay in the issue.

THE COMMITTEE ON PUBLICATIO[illegible]

* Probable errors of a printed catalogue-place.

Recent Observations of the Spectrum of *Mars*, by W. W. Campbell.

"In the year 1894, I described for the *Chronicle* my observations of the spectrum of *Mars*, and stated the conclusions to be drawn from them concerning the presence of atmosphere and water on that planet. The observations were made by visual methods entirely. In the spring of 1895 and the winter of 1896–97, I repeated the observations, making them by photography. Professor Keeler of the Allegheny Observatory (formerly of the Lick Observatory), recently wrote me that he also had observed the spectrum of *Mars* photographically in the last few months, and I have his permission to describe his results along with my own. Our work has an important bearing on the question of *Mars*' atmosphere and the conditions of life on that planet, and I take this opportunity of making it public. * * *

"The problem was attacked in the years 1862–77 by Huggins, Janssen, Vogel, and Maunder. All came to the conclusion that the spectroscope was able to detect evidence of atmosphere containing water-vapor. Their results supported the popular side of the question, and were accepted without reserve. Their observations were nearly all made under extremely unfavorable circumstances: with *Mars* near the horizon, with small telescopes, at stations near sea level and in very moist localities. I feel sure that the observers themselves would now be willing to say that much of their evidence was very discordant, and in some points it was erroneous. A case in court, based on similar evidence, would be dismissed, with costs levied on the plaintiff.

"While I believed that the early observations, though weak and discordant, were essentially correct, it seemed to me well worth while to repeat them at Mt. Hamilton, on account of the favorable circumstances of position and climate existing here. Among the advantages existing here may be mentioned: 1. A more powerful telescope and spectroscope. 2. The altitude of the observatory, eliminating the lower 4200 feet of atmosphere and its aqueous vapor. 3. The southern location of the observatory and the northern position of *Mars* in 1894, bringing the planet nearer the zenith. 4. The very dry air existing here in the early summer. With these and other favorable circumstances, I expected that a confirmation of previous results would be a simple and easy matter. Accordingly, I compared the Martian

and lunar spectra on several nights in 1894, when our atmosphere was remarkably dry, and the two bodies were at equal altitudes above the horizon. At all times the spectra of the two bodies appeared to be identical in every respect. The oxygen and aqueous vapor lines were stronger when the Moon and planet were near the horizon than when they were near the zenith, for the obvious reason, that in the lower positions the rays of light traversed the greater depth of our atmosphere. In fact, an increase of twenty-five to fifty *per cent.* in the length of path in our atmosphere seemed sufficient to change the spectrum appreciably.

"The conclusions to be drawn from the observations are very simple, yet they have been widely misunderstood. They are 1. The observations furnish no evidence of the existence of a Martian atmosphere containing aqueous vapor. 2. They do not prove that *Mars* has no atmosphere, nor do they even suggest that idea. They simply set a limit to the possible extent of the atmosphere, or, rather, to the quantity of oxygen and aqueous vapor contained in it. The light coming to us from *Mars* has been reflected from the planet's surface, or from the inner strata of its atmosphere, and has, therefore, passed twice, either completely or partially, through its atmosphere. If an increase of twenty-five to fifty *per cent.* in the length of path of the rays in our atmosphere changes the spectrum appreciably, the Martian atmosphere should have been detected, if it is one fourth as extensive as ours. 3. We know, from the waxing and waning of the polar caps with the advent of winter and summer, respectively, that *Mars* has some atmosphere and some vapor analogous to our water-vapor, but we do not know how much. They do not seem to exist in sufficient quantities to be detected by spectroscopic methods; that is, they do not seem to be more than one fourth as extensive as on the earth, and they may be considerably less.

"As soon as my 1894 results were published, Messrs. HUGGINS and VOGEL repeated their observations of 1867 and 1873, respectively. Both were very positive in the early years that *Mars'* atmosphere and aqueous vapor were very easy to detect, and must, therefore, be of great extent. They were able, in 1894, to confirm their early work in some points, but in others they were not. This is not the place to make a scientific criticism of scientific results, but it should be stated that at the points in

the spectrum where HUGGINS said the aqueous vapor lines were stronger in *Mars* than in the Moon, VOGEL said no difference could be detected by him; and in the case of the vapor lines in another place in the spectrum, which VOGEL said were stronger in *Mars* than in the Moon, HUGGINS did not detect any difference. The two distinguished observers did not agree with each other in even a single point.

"As stated above, the 1894 results were arrived at entirely by visual methods. The past winter, Professor KEELER and I, working independently, repeated my 1894 work, using the photographic method. We photographed the spectrum of *Mars* and the Moon when these bodies had equal altitudes. After a few trials, it was easy to determine the exposure time necessary to make the two photographic images of the same density. When the negatives were developed, it remained only to compare the spectra to detect any differences that might exist. Neither Professor KEELER nor I was able to detect the slightest difference between the spectrum of *Mars* and that of the Moon. (It should be said that the aqueous vapor lines most studied by the various observers lie in the yellow and orange of the spectrum, and to record them photographically it was necessary to use orthochromatic plates. The oxygen lines lie wholly, so far as we know, in the red, and could not be photographed satisfactorily. The investigation applies, therefore, only to the aqueous vapor lines.)

"Professor KEELER considered that if the Moon moved from the zenith down to an altitude less than forty-five degrees, its spectrum underwent appreciable changes: the vapor lines were the stronger in the lower position of the Moon. My estimate of the sensitiveness of the method was practically the same, or a trifle less, than KEELER'S. Now, the length of path in our atmosphere traversed by the Moon's rays, when at an altitude of forty-five degrees, is forty *per cent.* longer than when the Moon is in the zenith. Again we confirmed my visual results of 1894, since I then found that twenty-five to fifty *per cent.* increase in the length of path produced an appreciable change in the spectrum. Recalling that the light coming to us from *Mars* has passed twice, either completely or partially, through that planet's atmosphere, we arrive again at the result that the water-vapor there is not more than one fourth as extensive as on the Earth. (In speaking of 'extensiveness,' I mean the absolute quantity

of vapor above a given area — a square mile, for example — of the planet's surface.)

"Having been led, by the observations of 1894, to take the unpopular side of the question, *viz:* the oxygen and water-vapor (or some other vapor analagous to water-vapor) in *Mars*' atmosphere are of slight amount, probably not more than one fourth as extensive as on the Earth, — I may be pardoned for saying it is a pleasure to have so able and conscientious an observer as Professor KEELER write: 'No doubt you are entirely correct on the water-vapor question.'

"Assuming that the chemical constituents exist in the same proportions in the Earth's and *Mars*' atmospheres — we cannot say that they do — what would be the density of *Mars*' atmosphere at the planet's surface? If there is not more than one fourth as much atmosphere above a square mile on *Mars* as there is above the same area on the Earth, its density at the surface of the planet would be less than one eighth the density of our air at sea level; that is, it would be less than half as dense as the atmosphere at the summit of Mt. Everest. Such being the case, the conditions of life on the two planets would no longer be comparable. Astronomers would wisely turn the question of life on our neighboring planet over to the physiologists for solution; and possibly the latter would wisely hand it over to the domain of pure speculation for the present." — From the S. F. *Chronicle*, April 25, 1897.

MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS, HELD IN THE ROOMS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, MARCH 27, 1897, AT 7:30 P. M.

President HUSSEY presided. A quorum was present. The minutes of the last meeting were read and approved. The following members were duly elected:

LIST OF MEMBERS ELECTED MARCH 27, 1897.

Mr. GEO. M. EDGAR	University P. O., Tuscaloosa Co., Alabama.
Mr. L. L. HAWKINS	268 Oak St., Portland, Oregon.
FREE PUBLIC LIBRARY	Newark, New Jersey.
LIBRARY OF THE UNIVERSITY OF ILLINOIS	Champaign, Illinois.
LIBRARY OF THE UNIVERSITY OF INDIANA	Bloomington, Indiana.
Mr. JOHN W. SALSBURY	Clear Water Harbor, Florida.
Mlle. LE BRUN DE SURVILLE	3242 Sacramento St., S. F., Cal.
Mr. GEORGE TAYLOR	Walnut St., Brookline, Mass.
Mr. WILLIAM YATES	Box 283, Station C, Los Angeles, Cal.

The following resolution was, on motion, adopted:

WHEREAS, On the 12th day of January, 1891, the sum of $70.89 was paid out of the Alexander Montgomery Library Fund for sixty Comet-Medals, which amount should have been paid out of the DONOHOE Comet-Medal Fund;

Be it resolved, That the Treasurer be instructed to transfer said sum of $70 89 from the DONOHOE Comet-Medal Fund to the Alexander Montgomery Library Fund. [*]

The Library Committee presented its report, as follows, and the report was, on motion, adopted and filed:

SAN FRANCISCO, CAL., March 27, 1897.

Board of Directors, Astronomical Society of the Pacific, San Francisco, California:—

GENTLEMEN—At your meeting of January 30, 1897, the following resolutions were adopted:

"WHEREAS, The Society possesses a considerable number of valuable books and periodicals that are still unbound; and

"WHEREAS, A considerable portion of the income from the Alexander Montgomery Library Fund remains unexpended; be it therefore

"*Resolved*, That the unexpended portion of the accrued interest from this fund be expended:—

"1. For bindings for valuable unbound books and periodicals already in the possession of the Society; and then, if any portion of this income remains unexpended,

"2. For the purchase of additional astronomical books and periodicals; and be it further

[*] It seems proper to say here that the medals in question were bought in Paris, in 1890, by the Chairman of the Comet-Medal Committee. They could not be paid for from the principal of the medal-fund (which can not be impaired), nor from its interest (which was not sufficient). Accordingly, on December 15, 1890, the Chairman wrote to the Treasurer of the Society (Mr. MOLERA) to request that their cost be defrayed, provided the Directors approved, from the *General Fund* (not the Library Fund).

EDWARD S. HOLDEN.

"*Resolved*, That the President and Library Committee be authorized to carry these provisions into effect."

We beg to report, that by virtue of the authority granted by the above resolution—we have examined with care the unbound books, periodicals, and pamphlets in possession of the society, and have prepared and sent to the binders 101 volumes.

We have delivered these books to the Hicks-Judd Company, 23 First Street, San Francisco, for binding. Their schedule of prices for this work is given in their letters of March 13, 1897, which are appended to, and made a part of, this report.

In the case of periodicals and works issued in parts, we have found that numbers are sometimes missing. Such volumes have not been sent to the binders. We have written to some of our exchanges for missing numbers; we have ordered the missing numbers of the *Astronomische Nachrichten* from Dr. Kreutz, Kiel, Germany, the remaining parts of Proctor's *Old and New Astronomy*, from Messrs. Longmans, Green & Co., 15 East 16th St., New York City.

From Prof. W. W. Payne, Northfield, Minn., we have ordered Vol. 1 of the *Sidereal Messenger*, to complete our set, and Vols. 1 to 5, inclusive (the last to be sent as issued), of *Popular Astronomy*. The Society already has Vols. 95 to 128 of the *Astronomische Nachrichten*. We have ordered the first ninety-four volumes of this important periodical from F. A. Brockhaus, Leipzig, Germany, at a cost (our offer) of $300.

We have directed all bills to be sent to the Secretary of the Society in San Francisco. We have arranged our orders so as to leave a sufficient balance of the funds available to cover freight and other charges that may yet arise in connection with our purchases.

(Signed) W. J. Hussey,
President A. S. P.
E. J. Molera,
Rose O'Halloran,
Chas. Burckhalter.

I wish to go on record that the ninety-four vols., *A. N.*, were bought without my knowledge, and I would not have consented to such a large expenditure. C. B.

Minutes of the Annual Meeting of the Astronomical Society of the Pacific, held in the Lecture Hall of the California Academy of Sciences, March 27, 1897.

The meeting was called to order by President Hussey. A quorum was present. The minutes of the last meeting were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The following papers were presented:

1. Address of the retiring President, by Prof. W. J. Hussey.
2. Reports of Committees: on Nominations; on the Comet-Medal; on Auditing; and Annual Report of the Treasurer.
3. Astronomical Observations made in 1896, by Mr. Torvald Köhl, of Odder, Denmark.
4. Predictions for the Solar Eclipse of July 29, 1897, for Mt. Hamilton and San Francisco, by Mr. C. D. Perrine.
5. Planetary Phenomena for May and June, 1897, by Prof. M. McNeill, of Lake Forest, Illinois.
6. Ephemeris for physical observations of the Moon for certain dates between 1890 and 1895, by A. Marth, F. R. A. S., of Markree, Ireland.

The Committee on Nominations reported a list of names proposed for election as Directors, as follows: Messrs. ALVORD, HOLDEN, MOLERA, MORSE, PERRINE, PIERSON, SEARES, ST. JOHN, VON GELDERN, ZIEL, and Miss O'HALLORAN.

For Committee on Publication: Messrs. HOLDEN, BABCOCK, AITKEN.

Messrs. BURCKHALTER and BRASCH were appointed as tellers. The polls were open from 8:15 to 9 P.M.

After counting the ballots, the tellers announced that the following persons had received a majority of the votes cast, namely: For Directors—Messrs. ALVORD, HOLDEN, MOLERA, MORSE, PERRINE, PIERSON, SEARES, ST. JOHN, VON GELDERN, ZIEL, and Miss O'HALLORAN. For Committee on Publication—Messrs. HOLDEN, BABCOCK, AITKEN.

The Chairman declared these persons duly elected, to serve for the ensuing year.

REPORT OF THE COMMITTEE ON THE COMET-MEDAL, SUBMITTED MARCH 27, 1897.

This report relates to the calendar year 1896. The comets of 1896 have been:

Comet *a:* (unexpected comet), discovered by Mr. C. D. PERRINE, Assistant Astronomer in the Lick Observatory, on February 15th.

Comet *b:* (unexpected comet), discovered by Dr. LEWIS SWIFT, Director of the LOWE Observatory, on April 13th.

Comet *c:* (periodic comet), 1889 V (BROOKS), re-discovered by M. JAVELLE, Astronomer of the Observatory of Nice, on June 20th.

Comet *d:* (unexpected comet), discovered by Mr. W. E. SPERRA, of Randolph, Ohio, on August 31st.

Comet *e:* (unexpected comet), discovered by M. E. GIACOBINI, Assistant Astronomer of the Observatory of Nice, on September 4th.

Comet *f:* (unexpected comet), discovered by Mr. C. D. PERRINE, Assistant Astronomer in the Lick Observatory, on November 2d.

Comet *g:* (unexpected comet), discovered by Mr. C. D. PERRINE, Assistant Astronomer in the Lick Observatory, on December 8th.

On September 21st, two comets were reported by Dr. LEWIS SWIFT, Director of the LOWE Observatory. As no positions of these objects were secured elsewhere, they have not been included in the list of comets for the year.

The Comet-Medal has been awarded to the discoverers of Comets *a*, *b*, *d*, *e*, *f*, *g*, in accordance with the regulations.

Respectfully submitted,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. W. CAMPBELL,
Committee on the Comet-Medal.

The Treasurer submitted his Annual Report, as follows:—

Annual Statement of the Receipts and Expenditures of the Astronomical Society of the Pacific for the Fiscal Year ending March 27, 1897.

GENERAL FUND.

Receipts.

Cash Balance, March 28, 1896			$ 580 73
Received from dues		$1491 32	
" " sale of publications and reprints		99 00	
" " advertisements		75 00	
" " Comet-medal Fund (engraving 21 medals)		21 00	
" " Security Savings Bank (interest)		1 99	
" " Life Membership Fund (interest)		55 08	
" " " " " (loan August 5, 1896)		125 00	
		$1868 39	
Less transfer to Life Membership Fund	$ 50 00		
Returned to Life Membership Fund (loan of August 5, 1896)	125 00	175 00	1693 39
			$2274 12

Expenditures.

For publications	$1099 93	
" general expenses	684 90	
		$1784 83
Cash Balance March 27, 1897		489 29
		$2274 12

LIFE MEMBERSHIP FUND.

Cash Balance March 28, 1896		$1700 61	
Received from General Fund		50 00	
" " " " (loan of August 5, 1896, returned)		125 00	
" " interest		55 08	
		$1930 69	
Less interest transferred to General Fund	$ 55 08		
" loan to General Fund (August 5, 1896)	125 00	180 08	
Cash Balance March 27, 1897			$1750 61

DONOHOE COMET-MEDAL FUND.

Cash Balance March 28, 1896	$ 674 32	
Interest	22 72	
	$ 697 04	
Less transfer to General Fund for engraving 21 medals	21 00	
Cash Balance March 27, 1897		$ 676 04

ALEXANDER MONTGOMERY LIBRARY FUND.

Cash Balance March 28, 1896	$1857 38	
Interest	75 30	
Cash Balance March 27, 1897		$1932 68

FUNDS.

Balances on Deposit as follows:

General Fund:		
with Donohoe-Kelly Banking Co	$ 285 33	
" Security Savings Bank	203 96	
		$ 489 29
Life Membership Fund:		
with San Francisco Savings Union	$ 550 61	
" German Savings and Loan Society	600 00	
" Hibernia Savings and Loan Society	600 00	
		1750 61
Donohoe Comet-Medal Fund:		
with San Francisco Savings Union	$ 266 76	
" German Savings and Loan Society	204 63	
" Hibernia Savings and Loan Society	204 65	
		676 04
Alexander Montgomery Library Fund:		
with San Francisco Savings Union	$ 670 68	
" German Savings and Loan Society	648 10	
" Hibernia Savings and Loan Society	613 90	
		1932 68
		$4848 62

SAN FRANCISCO, March 27, 1897. F. R. ZIEL, *Treasurer.*

The committee appointed to audit the Treasurer's accounts reported as follows, and the report was, on motion, accepted and adopted:

To the President and Members of the Astronomical Society of the Pacific:—

GENTLEMEN—Your committee appointed to audit the accounts of the Treasurer for the fiscal year ending March 27, 1897, have made a careful examination, and find same to be correct. Yours respectfully,

F. H. McCONNELL.
D. F. TILLINGHAST.

President HUSSEY then read his annual address.

The following resolution was, on motion, adopted:

Resolved, That all the acts appearing in the minutes of the meetings of the Board of Directors of this Society, as having been done by said Board during the past fiscal year, are here now, by this Society, approved and confirmed.

The thanks of the Society were returned to the California Academy of Sciences for the use of the lecture hall.

Adjourned.

Minutes of the Meeting of the Board of Directors of the Astronomical Society of the Pacific, held in the Rooms of the Society, March 27, 1897, at 9:45 p.m.

On motion of Mr. Molera, Mr. St. John took the chair, and called the meeting to order. A quorum was present. The minutes of the last meeting were approved.

The business in hand being the election of officers and committees for the ensuing year, the following officers and committees, having received a majority of the votes cast, were duly elected:

President: Mr. William Alvord.
First Vice-President: Mr. Edward S. Holden.
Second Vice-President: Mr. Frederick H. Seares.
Third Vice-President: Mr. Chauncey M. St. John.
Secretaries: Messrs. C. D. Perrine and F. R. Ziel.
Treasurer: Mr. F. R. Ziel.
Committee on the Comet-Medal: Messrs. Holden (*ex-officio*), Schaeberle, Campbell.
Library Committee: Messrs. Hussey and Seares, and Miss O'Halloran. Mr. Hussey was appointed Librarian.

The President was authorized to appoint the members of the *Finance Committee* of the Board of Directors, and accordingly made the following selections:

Finance Committee: Messrs. Wm. M. Pierson, E. J. Molera, and C. M. St. John.

The *Committee on Publication* is composed of Messrs. Holden, Babcock, Aitken.

Adjourned.

OFFICERS OF THE SOCIETY.

Mr. William Alvord	*President*
Mr. Edward S. Holden	*First Vice-President*
Mr. Frederick H. Seares	*Second Vice-President*
Mr. Chauncey M. St. John	*Third Vice-President*
Mr. C. D. Perrine Mr. F. R. Ziel	*Secretaries*
Mr. F. R. Ziel	*Treasurer*

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NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

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A NEW OBSERVATORY (VALKENBURG, HOLLAND).

BY REV. JOHN G. HAGEN, S. J.

A small observatory has been erected at Valkenburg, Holland. It consists mainly of an equatorial of nine-inch aperture, and belongs to the Jesuit College of that city. The dome is constructed on the top of the building, at the northeast corner, the walls having been built especially strong for the purpose. The room under the dome contains a sidereal clock and switchboard, with relays, sounder, and chronograph, thus affording connections with the equatorial, with an outside pier for time observations, and with the telegraph office of the city. The same room serves as a library, which, it is hoped, will contain the publications of other observatories. This room, as well as the dome and all parts of the equatorial, is lighted by electricity from the dynamo of the college and a storage battery.

This new observatory has a special interest for Americans, since the equatorial is entirely of American make: the mounting by Mr. G. N. SAEGMULLER, and the optical part by Mr. J. CLACEY, both of Washington. The instrument had been especially constructed for and exhibited at the World's Fair in Chicago. It has the latest improvements, and is exceedingly light, the center-piece of the tube, the cell, and the eye-end being of aluminium. It contrasts very favorably with the clumsy mountings of some instruments of equal or even smaller aperture in European observatories. One of the finest features of the telescope is its adjustment in azimuth and altitude, close to the polar axis. Under this axis is the driving-clock, visible and accessible

through four glass doors, and provided with electric contrc The weights of this clock are inside the round iron pillar. De linations are set from the eye-end of the telescope by means of microscope, and Right Ascensions directly (without the hou angle) on a dial, which is moved by a sidereal clock at the low end of the polar axis. Just under this dial is a small han wheel for setting in R. A. The large base of the mounting under the floor, and the observing chair can be moved quite clo to the slender pillar. This chair was made by the carpenter the college, on the well-known plan of Professor HOUGH Chicago. The switchboard also presents an American appea ance. It is provided with the "spring-jacks" used in the Wes ern Union telegraph offices, and the connections of the wires a arranged on the plan of the Harvard College, Georgetown Cc lege, and Lick Observatories. The chronograph is of the Amei can type, with cylindrical barrel, and was constructed by tl mechanician of the college, according to plans kindly furnishe by Mr. SAEGMULLER, who also made a present of the whee and governor for the driving-clock. The batteries are tl "Edison-Lalande," furnished by BUNNELL & Co. of New Yor] and are admired for their constancy and cleanliness.

The Dutch Ministry kindly allowed the free import of th "telescope with accessories, for the sake of instruction." Tl fitting-up of the observatory was intrusted to the Director of tl Georgetown College Observatory, Father J. G. HAGEN, S. J and his plan was to adapt it principally to the observation variable stars. The light construction and the comparative short focus of the instrument render it especially fit for this pu pose, and superior to any telescope now exclusively devoted i this branch of astronomy. Its first Director, Mr. JOS. HISGEI S. J., is already known to the readers of the *Astronomisc* *Nachrichten* by his observations of variable stars, which he mac at the Georgetown College Observatory, in preparation for h new position.

THE SPECTRA AND PROPER MOTION OF STARS.

By W. H. S. Monck, F. R. A. S.

In the year 1892 I called the attention of the members of this Society to a connexion between the character of the stellar spectra and the proper-motion of the corresponding stars, which I afterward followed up in *Astronomy and Astro-physics* and elsewhere. I had hoped that by this time the Draper catalogue would have been extended to the Southern Stars, which would have enabled this theory to be subjected to a wider test. I recently met with a catalogue which seemed well suited for a test, though, of course, I had only the original Draper catalogue (with some corrections kindly supplied to me by Professor Pickering) to refer to. This was Dr. Rambaut's catalogue of stars observed at Dunsink, consisting mainly of stars with large proper-motion, which were observed with a view of detecting the existence of considerable parallaxes not previously noticed. Dr. Rambaut's limit was an annual motion of 0''.2 in a great circle; but, unfortunately, his catalogue does not contain the entire number of such stars which are capable of being observed at Dunsink (he appears to have limited himself to those respecting which no previous parallactic researches had been made), while it contains a number of stars with less than the requisite amount of proper-motion, which were observed at the request of Dr. Gill, Dr. Downing, and others; and no distinctive mark is applied to stars of this latter class. I soon found that, to select from the catalogue of 717 stars, those whose proper-motion amounted to 0''.2 and upwards would involve a good deal of calculation, and I therefore selected instead those whose proper-motion in Declination exceeded 0''.1. In doing so, no doubt I omitted some stars with a proper-motion of upward of 0''.2, but the omissions were not likely to make much alteration in the relative proportions of the stars with different spectra, with which alone I was concerned. Of the stars thus selected, 92 proved to be Capellan (spectrum E, F, or G), 59 Arcturian (spectrum H, I, K, or L), and only 11 Sirian (spectrum A, B, C, or D). There were very few stars with the spectrum M, and these were all near the lower limit. Thirteen solar stars to each Sirian star is rather a startling proportion, but had I adopted

0''.2 as the motion in Declination, the result would have been still more startling. There would have been *one* Sirian star (marked doubtful in the DRAPER catalogue) to over eighty solars. But Dr. RAMBAUT'S stars were selected without any regard to their spectra, and, I believe, without knowing what the spectra were.

Further, I suspect that several of the eleven Sirian stars in question will prove, on further examination, to be solar stars. For they are usually faint stars, and the DRAPER catalogue often expresses doubt as to the character of their spectra. Their numbers in the DRAPER catalogue are the following: 4637, 4989, 5207 (7 *Sextantis*), 5371, 7088, 8379 (111 *Herculis*), 9039, 9253 (56 *Cygni*), 9328 (5 *Equulei*), 9428, and 9842.

I had previously made a similar examination of the stars in the PULKOVA catalogue having a motion in Declination of over 0''.1 annually, but went over them a second time. These stars, of course, included several whose total proper-motion fell short of 0''.2 per annum, whereas the selected stars from Dr. RAMBAUT'S catalogue contained very few. I obtained (neglecting the notes of interrogation) 27 Sirian stars, 125 Capellan, and 80 Arcturian. The general fact was thus the same as before. I then tried the British Association catalogue for stars with a proper-motion of 0''.1 annually in Declination. The contrast was less strongly marked, probably because several faint stars are erroneously described as Sirian in the DRAPER catalogue. But the three classes of stars came out in the same order, Capellan first, Arcturian second, and Sirian third. This reverses the order in which they occur in the DRAPER catalogue. The Sirians largely outnumber the Arcturians, and the latter somewhat outnumber the Capellans. And taking the PULKOVA catalogue and identifying as many stars as possible with the DRAPER catalogue, I found that more than half were Sirians, and that of the remainder the Arcturians outnumbered the Capellans. But when I came to examine those with large proper-motion only, the relative numbers were reversed. Nor are these Capellan stars, on the average, of higher magnitude than the Sirians or Arcturians. The stellar magnitudes average about the same for all three classes. The fact appears to be — however it may be explained — that Capellan stars have, on the average, larger proper-motion than Arcturians of the same magnitude, and that Arcturian stars have, on the average, much larger proper-motion

than Sirians of the same magnitude. The proportion of Capellan stars having a proper-motion in Declination of 0″.1 annually in Declination is ten times as great as that of the Sirians, and twice as great as that of the Arcturians — at least, if we adopt the PULKOVA catalogue as the test. Such is the fact. How is it to be explained? Are the solar stars (and especially the Capellans) moving through space with greater absolute velocity than the Sirian stars? I believe not. There are two tests on this subject: first, the spectroscopic results as regards motion in the line of sight; and, secondly, the result of our investigations on parallax. The latter can hardly be relied on at present, though so far as they go they indicate a larger average parallax for solar stars than for Sirians of the same magnitude. VOGEL'S results as to motion in the line of sight appear more satisfactory, though his list of fifty-one stars contains but six Capellans. Their average motion is 9.5 miles per second, which is somewhat less than the general average. In fact, VOGEL'S observations would lead us to think that all three classes of stars are moving through space with nearly the same velocity. Another reason for arriving at this conclusion is, that the effect of the Sun's motion in space can be traced just as easily in the case of stars with large proper-motion as in the case of stars with small proper-motion; whereas, if the former were really traveling with double or more than double the usual velocity, the effect of the Sun's motion on them would be comparatively small. Are the Capellan stars, then, small stars or dull stars? The latter is, I believe, the true alternative. The great number of double-stars of this type which are known to be binary tends to this result. The smaller the mass of the pair, the slower will be the revolution of the satellite, and the greater will be the difficulty in ascertaining the binary character of the pair and determining the orbit. But I believe it will be found that more than one half of the binary stars whose orbits are approximately known belong to the Capellan type. I pointed out, some years ago, a formula by which the luminosity of two binaries can be compared with each other, assuming that the larger stars were globes of equal density, and their companions very small, compared with them. The result of applying this formula to the Sirian and Capellan binaries whose orbits were supposed to be known was to show that the former were much more luminous than the latter—probably five times as much so. The Arcturian binaries were puzzling. They appeared to occupy

both extremes in the scale of luminosity. But the orbits assumed for γ *Leonis* and 61 *Cygni* were probably entirely wide of the mark; and omitting these, they are certainly less luminous than the Sirians; but their position as regards the Capellans is more difficult to define. In fact, there are not enough of them to settle it satisfactorily. There appear to be as many Arcturian as Capellan double-stars, but among known binaries the latter are five or six times as numerous. In like manner, Sirian double-stars are numerous enough, but only a small proportion are known to be binaries. That the vast majority of double-stars are binaries, a careful examination will, I think, lead us to conclude; but good observations on their positions being all of comparatively recent date, we are still without means of proving this fact when the period is very long. Now, *ceteris paribus*, the greater the mass of the pair, the shorter will be the time of revolution; and the shorter periods of revolution in the case of the Capellan double-stars go far to displace the theory that these stars are unusually small. Indeed, unless they are nearer to us than the others, we should be driven to conclude that their masses were greater than those of either the Sirians or the Arcturians. Capellan stars will, I believe, prove not to be the smallest, but the least luminous class of stars—least luminous, at least, relative to their density for there are some reasons for thinking that a Sirian star, instead of presenting a much brighter surface than a Capellan of the same mass, presents a much greater extent of surface. The Capellan is rather denser than duller; but, mass for mass, it gives much less light.

These results may not be inconsistent with a theory of stellar development, but if so, it must assume a different form from that which would naturally occur to us. If the Sirian, Capellan, and Arcturian stars represent different stages of stellar development, dependent on cooling and condensation, we must place the Capellan stage last, not second. And if stars pass through what is called the third type of spectrum (designated by M in the DRAPER catalogue), they must do so before reaching the Capellan stage. Very few of the stars with this kind of spectrum possess large proper-motion. The number which I have identified in the PULKOVA catalogue is under fifty, some of which are queried but only four of these have a proper-motion in Declination of over 0''.1, thus giving a smaller percentage than even the Arcturians. Unless they are, on the average, larger stars than the

Capellans,—and we would not be likely to find the largest stars in the last stage of cooling—they are evidently more luminous, relative to their density, and must, therefore, represent an earlier stage of evolution.

The stars of the Orion type, designated B in the DRAPER catalogue, have less proper-motion than even the ordinary Sirians, denoted by A. On the development theory, they represent the earliest stage, while the Capellans represent the latest. If we cannot represent the development as taking place in this order, the stars must differ in kind—probably composed of different elements. One circumstance which rather favors the theory of development is, that every star of the Algol type whose spectrum I have succeeded in identifying—including those like *Spica Virginis* and *β Aurigæ*, where no actual eclipse at present takes place—are Sirians. On the tidal theory of satellite development, the Algol type of stars belong to the earliest stage, their satellites ultimately developing into the binary systems with moderate periods, which are so frequently found among the the Capellans. The duration of the eclipses in the case of these Algol stars, compared with the intervals between them, indicate a low density for these stars; and this character may not improbably belong to all the Sirian stars. It is possible that, as they become condensed by the cooling process, and their satellites driven to a greater distance by tidal action, they may become Capellans. But, then, where do the Arcturians come in? I can offer no plausible theory on this subject.

In conclusion, I desire to point out that if Sirian stars are, *celeris paribus*, visible at a much greater distance than Arcturians, and the latter visible at a greater distance than Capellans, we must not regard the DRAPER catalogue as indicating the relative frequency with which these classes of stars occur in space. Supposing that the Sirians and Capellans were equally numerous, and that both were uniformly distributed, but that the former were (on the average) visible at double the distance of the latter, we might expect to find eight times as many Sirians as Capellans in the DRAPER catalogue. The actual proportion is about 2½ to 1; and the natural inference appears to be that the Capellan stars are really more numerous than the Sirians. The apparent numerical superiority of the latter is probably a delusive appearance arising from their greater luminosity. And it is evident that in the case of a distant cluster, a number of Sirian stars may

be distinctly visible when the light of their Capellan companions is too faint to enable them to be observed separately. This fact should not be lost sight of in speculations relative to the structure of the Galaxy. Certainly, among the nearer stars which are in the same direction as the Galaxy, many (including the famous *α Centauri* and 61 *Cygni*) are of the solar type. Is there any valid reason for regarding the more distant stars in this direction as almost exclusively Sirian? I think not.

THE SPECTRA AND PROPER-MOTION OF STARS.

[SUPPLEMENTAL NOTE.]

BY W. H. S. MONCK.

Having obtained the spectra and proper-motion of a larger number of stars than I had hitherto done by a comparison of the British Association catalogue with the DRAPER catalogue, I thought it desirable to take the different sub-classes into which Professor PICKERING divides the stellar spectra separately. I found a sufficient number of stars with the following spectra to render a comparison feasible; viz. A, B, E, F, G, H, I, K, and M. I compared the proper-motions of the stars of these types (rejecting, in the first instance, all those marked with a note of interrogation in the DRAPER catalogue) in Declination or North Polar Distance, only ascertaining what proportion of them had a proper-motion of one tenth of a second annually in this direction. All my percentages are somewhat too small, because the divisor included some stars whose proper-motion is not given in the British Association catalogue, but whose spectra I copied into my note-book, with a view of subsequently ascertaining their proper-motions from some other source, which I have not yet done. The percentages which I obtained were as follows:—

Spectrum.	Percentage of stars with requisite motion.
B	0.0
A	8.8
H	16.0
M	16.7
I	18.9
K	22.6
F	31.2
E	31.7
G	40.7

The stars of this last type were not numerous enough to justify the conclusion that the proper-motion is really greater than those of the types E and F.

While the stars classed as A gave a percentage of 8.8, those marked A? (of which there were over 130) gave a percentage of 12.8. This was to be expected, as the intrusion of stars of any other type (except B) would increase the average proper-motion. On the other hand, the stars marked F? gave only 22.6 per cent. and those G? 25.0; but those marked E? gave the high percentage of 36.8. Classing E, F, and G, however, together as Capellan stars, the unqueried Capellans gave a percentage of 31.8, and the queried Capellans a percentage of 28.9, thus confirming the result that the intrusion of stars of any other type among the Capellans will reduce their average proper-motion. H? gave a percentage of 12.6, as compared with 16.0 for H; but I? and K? gave 24.4 and 29.0 as compared with 18.9 and 22.6 for unqueried stars of the same types. On the whole, if we designate the types H, I, and K as Arcturian, the queried Arcturian stars gave a little more proper-motion than the unqueried. The reverse is true of the type M. The extremely low proper-motion of the stars of the Orion type B is remarkable. I had seventy-five of them to compare, the proper-motions of seventy-two being known. Not one of these had a proper-motion of one tenth of a second in N. P. D., while out of twenty-seven stars of the type G, no less than eleven possessed it. It will be seen that the superior proper-motion of the Capellan stars over the Arcturian (with which stars of the type M may be classed) is quite as strongly marked as that of the Arcturian over the Sirian.

This difference of proper-motion will, I think, be found to arise not from the greater actual velocity, but from the greater nearness (on the average) of the Capellan stars. The entire subject, however, calls for further investigation.

THE SAYRE OBSERVATORY, SOUTH BETHLEHEM, PENNSYLVANIA.

BY C. L. DOOLITTLE.

On the first day of September, 1866, occurred the formal opening of the Lehigh University, at South Bethlehem, Pennsylvania. Professor ALFRED M. MAYER, now connected with the STEVENS Institute of Technology, was the first professor of astronomy, which department was then united with that of physics.

Professor MAYER felt that the attempt to teach astronomy with no instrumental means was most unsatisfactory, and mainly through his efforts, Mr. ROBERT H. SAYRE, one of the most prominent men of the place, and a trustee of the University, became interested in the matter, and undertook to provide means or a small observatory. The result was the founding of the SAYRE Observatory, in 1868.

The plan was not an ambitious one, the total cost of building and instruments being only about $5000.00.

The equipment consisted of a six-inch equatorial, by ALVAN CLARK & SONS; a portable transit instrument, by STACKPOLE; a sidereal clock, by BRAND; and, finally, an old zenith telescope, which is said to have been rejected by the U. S. Coast Survey, and which was purchased for a small sum, economy being a matter of necessity. It was with this instrument, repaired by KAHLER in 1875, and afterward by SAGMÜLLER in 1888 and 1892, that a series of latitude observations was carried on by the writer for a number of years, the results of which, it is believed, have been of some service in determining what is now known of the law of latitude variation.

Professor MAYER was more interested in physics than in astronomy, yet he found time for research work at the observatory, mainly in the direction of solar physics. He was succeeded in 1871 by HIERO B. HERR, the chair of astronomy being now connected with that of mathematics. Professor HERR retired in 1874, the vacancy being filled one year later by the election of C. L. DOOLITTLE, who remained in charge for a period of twenty years. He was succeeded, in 1895, by C. L. THORNBURG, the present incumbent.

The original purpose of the observatory was that of instruc-

tion, and this has always been a prominent feature of its work. The university furnishes a very full course in astronomy, an important feature of which is found in the practical work at the observatory.

Considerable use has been made of the equatorial in the observation of planets and comets, and the phenomena of *Jupiter's* satellites; but the most important contribution to astronomy made by this observatory is the long series of latitude determinations. This series came to an end in August, 1895, but it is much to be desired that it should be resumed in the near future.

TOTAL SOLAR ECLIPSE, JANUARY 22, 1898. ENGLISH PREPARATIONS.

By Edward W. Maunder, F. R. A. S.

The importance of total solar eclipses has led in England to the appointment of a permanent body to organize their observations. This body bears the rather unwieldy title of the "Joint Permanent Eclipse Committee of the Royal Society and Royal Astronomical Society." The title is, however, descriptive of its constitution, and if we refer to it in future simply as the "Eclipse Committee," there need be no misunderstanding as to the body indicated, and we may avoid repetition of this cumbrous name.

The expeditions sent out by the Eclipse Committee last August were to widely separated countries,—Japan and Norway—and included six principal observers. Three—the Astronomer Royal, Professor H. H. Turner, and Captain Hills—went to Japan; three—Professor Norman Lockyer, Mr. Fowler, and Dr. A. A. Common—went to the Varanger Fjord, in Lapland. The same observers, so far as can be at present foreseen, will go to India for the eclipse of January next, and will take with them the same instruments, and try to carry out the same programme as that to which the clouds were so hostile on August 9, 1896. For, one chief aim to be borne in mind in eclipse observation is the necessity of strict continuity. If we are to get the maximum result from the brief moments of totality afforded us at such long intervals, then the operations to be undertaken at any one eclipse must bear the strictest relation to the work done at the eclipses that have gone before, and to the work proposed for those that

will follow. It is hoped, however, that the party on the next occasion will be increased by two additional members; one will probably be Mr. NEWALL, the observer with the great NEWALL telescope at Cambridge; the other was to have been Mr. E. J. STONE, the Radcliffe observer, whose untimely death has recently left so serious a gap in the ranks of English astronomers. No arrangement has as yet been made for supplying his place on the expedition.

If we take the stations at present proposed to be occupied, beginning with the most westerly, the first party we come to is that of Professor LOCKYER and Mr. FOWLER, who will be stationed near Ratnagore, on the west coast. The equipment will be chiefly spectroscopic, and will include two telescopes of nine and six inches aperture, respectively, furnished with objective prisms, the great success which attended this method in 1893 and again in Mr. SHACKLETON'S observations in Novaya Zemla in 1896 amply justifying great importance being attached to it. An integrating spectroscope, having two three-inch prisms of sixty degrees, will also be used. The method of observation with all three instruments will, of course, be photographic, a long series of photographs of varying exposures being used with the objective prisms, whilst an exposure of sixty seconds will be given with the integrating spectroscope.

The object of the prismatic cameras is, of course, to give the details of the bright line spectra of the chromosphere, prominences and corona, each several luminous point having its own distinct spectrum. The integrating spectroscope, on the other hand, is intended to sum up the spectrum of the whole composite phenomenon. It may be hoped, therefore, that the feeble intensity of the true coronal lines will be more than compensated by the breadth of the area over which they are diffused. If, then, on comparing the spectra obtained with these two widely differing instruments, we find that the integrating spectroscope brings into considerable evidence new lines beside those which the objective prism reveals to us as characterizing the prominences, there can be no hesitation in referring these new lines to the corona.

Crossing the Western Ghauts, the shadow-track intersects two main lines of railway (the Southern Mahratta Railway and the Great Indian Peninsular Railway), running southward from Bombay through Poona. The points where these two railway lines cross the line of totality will be very strongly occupied, but the

precise spots are not as yet definitely fixed. Most likely, the expedition sent by the Eclipse Committee will occupy the one station, whilst a numerous band, organized in India itself by Professor K. D. NAEGAMVALA, of Poona, will occupy the other.

The official party in this region will consist of the Astronomer Royal, Professor H. H. TURNER, and Dr. A. A. COMMON. The Astronomer Royal will take the THOMPSON photoheliograph of nine inches aperture and eight feet six inches focal length, with secondary magnifier placed a short distance within the focus, giving an image of the Sun four inches in diameter. The camera will be furnished with eight plate-holders, taking 12 x 10-inch plates, and the instrument will be fed by a coelostat with a sixteen-inch plane-mirror. Photographs will be taken of the partial phase, as well as of the total.

Professor TURNER'S apparatus is the double camera used in the West African expedition in 1893 by Sergeant KEARNEY. The body of the instrument is six feet long, and consists of two square tubes of 7x7-inch section. In one is placed the "ABNEY" photographic lens, of four inches aperture and five feet two inches focal length, used in so many eclipses, and which gives an image of the Sun 0.57 inch in diameter; in the other, the photoheliograph objective No. 2, belonging to the Royal Observatory, Greenwich, and used in the Transit of *Venus* Expedition of 1874, and which is also of four-inch aperture and five feet focal length, but which is to be used with a DALLMEYER secondary magnifier of seven and one half inches focus, placed five inches within the focus, so as to give an image of the Sun one and one half inches in diameter. The double camera is furnished with six plate-holders, each taking two plates of 160 mm. square, both plates being exposed by a quarter turn of one shutter. The double camera, like the Astronomer Royal's instrument, will be fed by a sixteen-inch plane mirror, on a coelostat mounting. A similar instrument was to have been placed under the charge of the late Mr. STONE at the third station. This instrument was taken by Dr. COMMON, in 1896, to Lapland.

Apart from this, it is probable that Dr. COMMON'S equipment will be the same as that which he had in Norway last year; i. e. a six-inch doublet lens, by GRUBB, lent by Mr. F. MACLEAN, F. R. S., and giving an image of the Sun three and one half inches in diameter; a slit spectroscope, with 3½-inch lenses, and two light flint prisms of sixty degrees, and a grating

spectroscope, to be used without a slit. The plates for Mr. CHRISTIE'S coronal photographs, Dr. COMMON'S photographs with the six-inch GRUBB, and those with the grating spectroscope, are all to be 12 x 10 plates.

The third station, at Wardha, on the Great Indian Peninsular Railway line from Bombay to Nagpur, will be occupied by Mr. NEWALL, who proposes to use a large slit spectroscope, with two prisms of sixty-two degrees, in the attempt to determine the speed of rotation of the corona by the relative displacements of its lines as observed east and west of the Sun. In the same neighborhood, Captain HILLS will probably fix his apparatus, which will consist of two slit spectroscopes, having the slit tangential to the Sun's limb at the point of second contact, and diametral respectively. The slits are 1½ x 0.004 inches, and 2 x 0.004 inches respectively; and the prisms are, for the first spectroscope, of two flint prisms of sixty degrees, 4½-inch base, 2½-inch height at minimum deviation for $H\gamma$; and for the second spectroscope, of four quartz prisms of sixty degrees, 3¼-inch base, 2¾-inch height at minimum deviation for $H\epsilon$. The collimator and camera lenses are single quartz lenses, of 2½-inch aperture, 30-inch focus and 3-inch aperture, 36-inch focus respectively. The objectives are all achromatic COOKE lenses, of 4½-inch aperture, 5 feet 10 inches focus, and a single quartz lens of 5-inch aperture, 4 feet 9 inches focus.

Professor TURNER'S equipment in Japan also included a polariscopic apparatus, consisting of an ordinary slit spectroscope, with an Iceland spar double image prism substituted for the ordinary prisms. This will probably again be included in his armory.

Some thirty or forty amateur astronomers belonging to the British Astronomical Association will also proceed to India, and divide into four companies, stationed near the four above-mentioned sites respectively, but the precise programmes to be adopted cannot be ascertained at present.

EARTHQUAKE OF JUNE 20, 1897 (OAKLAND).

BY ALLEN H. BABCOCK.

A prolonged shock of earthquake was observed here to-day, commencing at $12^h\ 13^m\ 9^s$ P. M., P. S. T., and continuing for at least twenty-five seconds. It was noticed first as a sharp settling of the floor; then came a rumbling sound, followed by a slow, swaying motion, which gradually increased in strength and frequency for about ten seconds, when the maximum was reached. At this time the vibrations were decidedly marked: the house creaked, the windows rattled, and the pictures bumped against the walls. The swing of the chandeliers was in an approximately north and south line. The vibration gradually diminished, until $12^h\ 13^m\ 34^s$, when they could no longer be observed. In a jeweler's shop, about two blocks away, a pendulum clock, which was fastened on a wall running in an east and west direction, had stopped at $12^h\ 13^m\ 27^s$. This clock is usually kept very close to standard time.

The intensity of the shock at its maximum may be estimated at IV, or possibly V, on the ROSSI-FOREL scale. Two persons report a very faint shock about fifteen minutes later, but it was not observed by me.

OAKLAND, Cal., June 20, 1897.

2826 California Street,
SAN FRANCISCO, June 23, 1897.

. . . On Sunday, June 20th, at 12:13 P. M., I felt a slight shock of earthquake, location N.W. ¼ Section 32, Township 17 S., Range 14 E., M. D. B. & M., on Cantua Creek, Fresno County. Duration about fifteen seconds; 9 shock; undulation and whirling motion. Yours respectfully, S. C. LILLIS.

PLANETARY PHENOMENA FOR JULY AND AUGUST, 1897.

BY PROFESSOR MALCOLM MCNEILL.

JULY, 1897.

Solar Eclipse. There will be an annular eclipse of the Sun on July 29th, visible on the morning of that day throughout the United States as a partial eclipse. The path of the annulus begins in the Pacific Ocean, crosses Mexico, skirts along the north shore of Cuba, just touches the northeast point of South America, and ends in the South Atlantic. The greatest duration of the annulus is considerably less than two minutes.

The Earth is in aphelion on the afternoon of July 9th.

Mercury is a morning star at the beginning of the month, rising a little more than an hour before sunrise, and may possibly be seen. It rapidly approaches the Sun, and passes superior conjunction on the afternoon of July 15th, and becomes an evening star. By the end of the month it is about as far from the Sun as it was at the beginning, but it is also too far to the south to be easily seen as an evening star.

Venus is a morning star, and comes to its greatest west elongation on July 7th. It rises about three hours before sunrise. It moves thirty-one degrees eastward and five degrees northward during the month, almost entirely in the constellation *Taurus*, and a little before the middle of the month passes through the *Hyades* group, between ϵ and δ *Tauri*.

Mars is well out on his way to conjunction with the Sun, and his apparent distance from the Sun is diminishing rapidly. By the end of the month it sets before 9 P.M. It moves seventeen degrees eastward and seven degrees southward in the constellation *Leo* during the month. On July 5th it passes about one degree north of the first magnitude star *Regulus* (α *Leonis*), and is in conjunction with *Jupiter* on the morning of July 25th. *Mars* is only seven minutes south of *Jupiter* at the time of nearest approach, but this occurs by daylight in the United States.

Jupiter is in the same quarter of the sky as *Mars*, and is moving in the same general direction but very much more slowly, the whole motion being only about five degrees during the month. Its conjunction with *Mars* is noted above.

Saturn is in good position for observation, being above the horizon until after midnight until nearly the end of the month. It is in the constellation *Libra*, and moves westward about one degree until July 28th, when it begins to move eastward again. The rings are widely opened, the ratio of minor to major axis being about 0.40.

Uranus is very near *Saturn*, about two degrees south and a little east, and is moving in the same general direction as *Saturn*, but does not stop its retrograde (westward) motion until August 2d. It may be easily found on any very clear, moonless evening as a small sixth magnitude star, about four diameters of the Moon, south and east of *Saturn*.

Neptune is a morning star in the eastern part of *Taurus*. *Venus* passes it about one degree south on the morning of July 28th.

AUGUST.

Mercury is an evening star, and sets about an hour after sunset during the greater part of the month. It may possibly be seen during good conditions of weather in the evening twilight. It reaches greatest east elongation on August 26th, more than twenty-eight degrees, its greatest apparent distance from the Sun during the year; but the conditions for evening visibility are not nearly as good as they were during the elongations of January and April, on account of its greater distance south of the Sun. It is in conjunction with *Jupiter* on the evening of August 12th, passing about two diameters of the Moon southward.

Venus is a morning star, rising about three hours before the Sun. It moves about thirty-six degrees eastward, through the constellation *Gemini* into *Cancer*, and will not be nearly as bright as it was during the early summer.

Mars is rapidly approaching the Sun, and by the end of the month it sets only about an hour later. It has lost the greater part of its brightness, and will not be at all a conspicuous object, but rather hard to see toward the close of the month. It moves about eighteen degrees east and south, through the constellation *Leo*.

Jupiter is still nearer the Sun than *Mars*, and its much smaller eastward motion allows the Sun to approach it much more rapidly. It cannot easily be seen much later than the middle of the month.

Saturn is still in fair position for observation in the south-

western sky in the early evening. It moves about one degree eastward in the constellation *Libra*. It is in quadrature with the Sun on August 16th.

Uranus keeps up about the same position relative to *Saturn* as during July, but is more nearly due south, about four diameters of the Moon distant. The two planets are in conjunction on the evening of August 25th.

Neptune is in the eastern part of *Taurus*, and rises before midnight at the end of the month.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

Phases of the Moon, P. S. T.

			H. M.	
First	Quarter,	July 7,	5 32	A. M.
Full	Moon,	July 13,	8 52	P. M.
Last	Quarter,	July 21,	7 8	A. M.
New	Moon,	July 28,	7 58	A. M.

The Sun.

1897.	R. A. H. M.	Declination. ° ′	Rises H. M.	Transits. H. M.	Sets. H. M.
July 1.	6 43	+23 6	4 41 A.M.	12 4 P.M.	7 27 P.M.
11.	7 24	+22 3	4 46	12 5	7 24
21.	8 4	+20 23	4 53	12 6	7 19
31.	8 44	+18 9	5 3	12 6	7 9

Mercury.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
July 1.	5 34	+ 22 35	3 33 A.M.	10 54 A.M.	6 15 P.M.
11.	7 2	+ 23 45	4 16	11 43	7 10
21.	8 32	+ 20 43	5 20	12 34 P.M.	7 48
31.	9 48	+ 14 46	6 20	1 11	8 2

Venus.

July 1.	3 31	+ 15 36	1 58 A.M.	8 52 A.M.	3 46 P.M.
11.	4 10	+ 17 41	1 49	8 51	3 53
21.	4 51	+ 19 29	1 45	8 54	4 3
31.	5 36	+ 20 46	1 44	8 58	4 12

Mars.

July 1.	9 53	+ 14 4	8 26 A.M.	3 14 P.M.	10 2 P.M.
11.	10 17	+ 11 52	8 17	2 58	9 39
21.	10 40	+ 9 32	8 8	2 41	9 14
31.	11 3	+ 7 6	8 1	2 25	8 49

Jupiter.

July 1.	10 33	+ 10 18	9 18 A.M.	3 53 P.M.	10 28 P.M.
11.	10 39	+ 9 39	8 47	3 20	9 53
21.	10 46	+ 8 58	8 17	2 48	9 19
31.	10 53	+ 8 14	7 48	2 16	8 44

Saturn.

July 1.	15 32	− 16 50	3 50 P.M.	8 51 P.M.	1 52 A.M.
11.	15 30	− 16 48	3 9	8 10	1 11
21.	15 29	− 16 47	2 29	7 30	12 31
31.	15 29	− 16 49	1 49	6 50	11 51 P.M.

Uranus.

July 1.	15 33	− 18 55	3 59 P.M.	8 52 P.M.	1 45 A.M.
11.	15 32	− 18 52	3 18	8 11	1 4
21.	15 31	− 18 50	2 38	7 31	12 24
31.	15 31	− 18 49	1 59	6 52	11 45 P.M.

Neptune.

July 1.	5 20	+ 21 48	3 23 A.M.	10 41 A.M.	5 59 P.M.
11.	5 22	+ 21 50	2 45	10 3	5 21
21.	5 23	+ 21 51	2 7	9 25	4 43
31.	5 24	+ 21 52	1 29	8 47	4 5

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off right-hand limb as seen in an inverting telescope.)

		H. M.			H. M.
I, **R**,	July 6.	7 0 P.M.	III, D,	July 19.	6 53 P.M.
IV, **D**,	9.	6 31 P.M.	III, R,	19.	10 4 P.M.
IV, **R**,	9.	10 10 P.M.	I, R,	22.	5 18 P.M.
III, **R**,	12.	6 5 P.M.	I, R,	29.	7 13 P.M.
I, **R**,	13.	8 55 P.M.			

MINIMA OF *ALGOL*, P. S. T.

	H. M.		H. M.
July 3.	7 34 P. M.	July 18.	3 38 A. M.
6.	4 23 P. M.	21.	12 27 A. M.
9.	1 12 P. M.	23.	9 16 P. M.
12.	10 1 A. M.	26.	6 5 P. M.
15.	6 50 A. M.	29.	2 54 P. M.

PHASES OF THE MOON, P. S. T.

		H. M.
First Quarter,	Aug. 5,	10 24 A. M.
Full Moon,	Aug. 12,	6 23 A. M.
Last Quarter,	Aug. 20,	12 29 A. M.
New Moon,	Aug. 27,	7 29 P. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Aug. 1.	8 47	+17 54	5 3 A.M.	12 6 P.M.	7 9 P.M.
11.	9 26	+15 8	5 13	12 5	6 57
21.	10 3	+11 57	5 22	12 3	6 44
31.	10 40	+ 8 28	5 32	12 0 M.	6 28

MERCURY.

Aug. 1.	9 55	+14 6	6 26 A.M.	1 14 P.M.	8 2 P.M.
11.	10 54	+ 7 12	7 9	1 33	7 57
21.	11 41	+ 0 37	7 38	1 40	7 42
31.	12 13	− 4 40	7 50	1 34	7 18

VENUS.

Aug. 1.	5 40	+20 52	1 43 A.M.	8 58 A.M.	4 13 P.M.
11.	6 27	+21 21	1 50	9 6	4 22
21.	7 16	+20 58	2 0	9 15	4 30
31.	8 4	+19 40	2 15	9 25	4 35

MARS.

Aug. 1.	11 5	+ 6 51	8 0 A.M.	2 23 P.M.	8 46 P.M.
11.	11 28	+ 4 18	7 53	2 7	8 21
21.	11 51	+ 1 42	7 45	1 51	7 57
31.	12 15	− 0 56	7 38	1 35	7 32

JUPITER.

Aug. 1.	10 54	+ 8 9	7 45 A.M.	2 12 P.M.	8 39 P.M.
11.	11 2	+ 7 22	7 15	1 40	8 5
21.	11 9	+ 6 34	6 47	1 9	7 31
31.	11 17	+ 5 44	6 18	12 37	6 56

SATURN.

Aug. 1.	15 29	−16 50	1 46 P.M.	6 47 P.M.	11 48 P.M.
11.	15 30	−16 54	1 7	6 8	11 9
21.	15 31	−17 1	12 29	5 30	10 31
31.	15 33	−17 10	11 51 A.M.	4 52	9 52

URANUS.

7.	R. A. H. M.	Declination. °	Rises. H. M.	Transits. H. M.	Sets. H. M.
1.	15 30	− 18 49	1 55 P.M.	6 48 P.M.	11 41 P.M.
11.	15 31	− 18 50	1 16	6 9	11 2
21.	15 31	− 18 52	12 37	5 30	10 23
31.	15 32	− 18 55	11 59 A.M.	4 52	9 45

NEPTUNE.

1.	5 24	+ 21 52	1 25 A.M.	8 43 A.M.	4 1 P.M.
11.	5 25	+ 21 52	12 47	8 5	3 23
21.	5 26	+ 21 53	12 9	7 27	2 45
31.	5 27	+ 21 53	11 30 P.M.	6 48	2 6

MINIMA OF *ALGOL*, P. S. T.

	H. M.		H. M.
1.	11 43 A. M.	Aug. 18.	4 36 P. M.
4.	8 32 A. M.	21.	1 25 P. M.
7.	5 21 A. M.	24.	10 14 A. M.
10.	2 9 A. M.	27.	7 3 A. M.
12.	10 58 P. M.	30.	3 52 A. M.
15.	7 47 P. M.		

DOUBLE-STAR MEASURES.

BY D. A. LEHMAN.

he following measures were made with the 12-inch equa- of the Lick Observatory. The position angle is the mean ur settings, and the distance that of three double-distances. position of the stars is given for 1880.0. In estimating g, a scale is used on which 5 stands for the most favorable itions. The eyepiece used in most of the measures has a r of 500 diameters; but some of the measures were made lower powers.

Σ 1788. (6.7–8).

R. A. $13^h\ 48^m\ 43^s$. Decl. — 7° 28′.

	θ_0	ρ_0	Seeing.
.460	73°.9	3″.37	3
.465	76 .1	2 .98	3+
7.477	75 .2	3 .62	4
7.492	77 .5	3 .23	4
7.47	75°.7	3″.30	

Σ 1930. (5–10).

R. A. 15^h 13^m 11^s. Decl. + 2° 13′.

	θ_o	ρ_o	Seeing.
1897.460	38°.7	11″.35	3
1897.492	37 .6	11 .04	4
1897.494	37 .5	10 .57	4
1897.48	37°.9	10″.99	

Σ 2021 (49 *Serpentis*). (6–7).

R. A. 16^h 7^m 43^s. Decl. + 13° 48′.

	θ_o	ρ_o	Seeing.
1897.460	332°.9	3″.97	3
1897.492	333 .9	4 .27	4
1897.514	335 .7	4 .29	3
1897.49	334°.1	4″.18	

Sh. 228 (ρ *Ophiuchi*). (5–7).

R. A. 16^h 18^m 23^s. Decl. — 23° 10′.

	θ_o	ρ_o	Seeing.
1897.508	354°.6	3″.60	3
1897.516	354 .4	3 .59	4
1897.519	353 .1	3 .12	4
1897.51	354°.0	3″.44	

Σ 2055 (λ *Ophiuchi*). (4–6).

R. A. 16^h 24^m 52^s. Decl. + 2° 15′.

	θ_o	ρ_o	Seeing.
1897.522	53°.3	1″.69	4
1897.525	52 .8	1 .63	4
1897.52	53°.0	1″.66	

Σ 3127 (δ *Herculis*). (3–8).

R. A. 17^h 10^m 6^s. Decl. + 24° 59′.

	θ_o	ρ_o	Seeing.
1897.514	189°.3	14″.93	3
1897.519	190 .1	15 .10	4
1897.522	190 .2	15 .17	4
1897.52	189°.9	15″.07	

URANUS.

1897.	R. A. H. M.	Declination. °	Rises. H. M.	Transits. H. M.	Sets. H. M.
Aug. 1.	15 30	− 18 49	1 55 P.M.	6 48 P.M.	11 41 P.M.
11.	15 31	− 18 50	1 16	6 9	11 2
21.	15 31	− 18 52	12 37	5 30	10 23
31.	15 32	− 18 55	11 59 A.M.	4 52	9 45

NEPTUNE.

Aug. 1.	5 24	+ 21 52	1 25 A.M.	8 43 A.M.	4 1 P.M.
11.	5 25	+ 21 52	12 47	8 5	3 23
21.	5 26	+ 21 53	12 9	7 27	2 45
31.	5 27	+ 21 53	11 30 P.M.	6 48	2 6

MINIMA OF *ALGOL*, P. S. T.

	H. M.		H. M.
Aug. 1.	11 43 A. M.	Aug. 18.	4 36 P. M.
4.	8 32 A. M.	21.	1 25 P. M.
7.	5 21 A. M.	24.	10 14 A. M.
10.	2 9 A. M.	27.	7 3 A. M.
12.	10 58 P. M.	30.	3 52 A. M.
15.	7 47 P. M.		

DOUBLE-STAR MEASURES.

BY D. A. LEHMAN.

The following measures were made with the 12-inch equatorial of the Lick Observatory. The position angle is the mean of four settings, and the distance that of three double-distances. The position of the stars is given for 1880.0. In estimating seeing, a scale is used on which 5 stands for the most favorable conditions. The eyepiece used in most of the measures has a power of 500 diameters; but some of the measures were made with lower powers.

Σ 1788. (6.7–8).

R. A. $13^h\ 48^m\ 43^s$. Decl. — 7° 28′.

	θ_0	ρ_0	Seeing.
1897.460	73°.9	3″.37	3
1897.465	76 .1	2 .98	3+
1897.477	75 .2	3 .62	4
1897.492	77 .5	3 .23	4
1897.47	75°.7	3″.30	

Σ 1930. (5–10).

R. A. 15ʰ 13ᵐ 11ˢ. Decl. + 2° 13′.

	θ_0	ρ_0
1897.460	38°.7	11″.35
1897.492	37 .6	11 .04
1897.494	37 .5	10 .57
1897.48	37°.9	10″.99

Σ 2021 (49 *Serpentis*). (6–7).

R. A. 16ʰ 7ᵐ 43ˢ. Decl. + 13° 48′.

	θ_0	ρ_0
1897.460	332°.9	3″.97
1897.492	333 .9	4 .27
1897.514	335 .7	4 .29
1897.49	334°.1	4″.18

Sh. 228 (ρ *Ophiuchi*). (5–7).

R. A. 16ʰ 18ᵐ 23ˢ. Decl. — 23° 10′.

	θ_0	ρ_0
1897.508	354°.6	3″.60
1897.516	354 .4	3 .59
1897.519	353 .1	3 .12
1897.51	354°.0	3″.44

Σ 2055 (λ *Ophiuchi*). (4–6).

R. A. 16ʰ 24ᵐ 52ˢ. Decl. + 2° 15′.

	θ_0	ρ_0
1897.522	53°.3	1″.69
1897.525	52 .8	1 .63
1897.52	53°.0	1″.66

Σ 3127 (δ *Herculis*). (3–8).

R. A. 17ʰ 10ᵐ 6ˢ. Decl. + 24° 59′.

	θ_0	ρ_0
1897.514	189°.3	14″.93
1897.519	190 .1	15 .10
1897.522	190 .2	15 .17
1897.52	189°.9	15″.07

β 416. (6–8).

R. A. $17^h\ 10^m\ 46^s$. Decl. $-34°\ 51'$.

	θ_o	ρ_o	Seeing.
1897.508	310°.6	1''.90	4
1897.519	311 .0	1 .77	4
1897.522	309 .2	1 .88	4
1897.525	309 .8	1 .89	4
1897.52	310°.2	1''.86	

Σ 2262 (τ *Ophiuchi*). (5–5.7).

R. A. $17^h\ 56^m\ 33^s$. Decl. $-8°\ 11'$.

	θ_o	ρ_o	Seeing.
1897.508	259°.1	2''.21	3
1897.514	256 .0	2 .15	3
1897.525	258 .2	1 .88	4
1897.52	257°.8	2''.08	

Σ 2272 (70 *Ophiuchi*). (4–6).

R. A. $17^h\ 59^m\ 23^s$. Decl. $+\ 2°\ 33'$.

	θ_o	ρ_o	Seeing.
1897.476	286°.2	2''.74	3
1897.492	280 .7	1 .91	4
1897.508	283 .9	2 .60	4
1897.49	283°.6	2''.42	

(γ *Coronæ Australis*). (5½–5½).

R. A. $18^h\ 58^m\ 18^s$. Decl. $-37°\ 14'$.

	θ_o	ρ_o	Seeing.
1897.508	158°.6	2''.12	4
1897.525	155 .0	1 .79	4
1897.52	156°.8	1''.95	

Σ 2579 (δ *Cygni*). (3–8).

R. A. $19^h\ 41^m\ 13^s$. Decl. $+\ 44°\ 50'$.

	θ_o	ρ_o	Seeing.
1897.508	301°.2	2''.25	4
1897.511	300 .1	1 .72	1+
1897.525	305 .1	1 .77	4
1897.52	302°.1	1''.91	

Σ 2583. (6–6.8).

R. A. $19^h\ 43^m\ 3^s$. Decl. + 11° 31′.

	θ_o	ρ_o	Seeing.
1897.508	115°.0	1″.90	4
1897.525	113 .2	1 .53	4
1897.52	114°.1	1″.72	

β 151 (β *Delphini*). (3½–4½).

R. A. $20^h\ 31^m\ 55^s$. Decl. + 14° 11′.

	θ_o	ρ_o	Seeing.
1897.511	359°.9	0″.75	3
1897.525	355 .2	.93	3
1897.52	357°.6	0″.84	

Lick Observatory, July 10, 1897.

NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

A NEW CELESTIAL ATLAS.

ATLAS DER HIMMELSKUNDE—Atlas of Astronomy, based on celestial photographs—sixty-two atlas sheets, with 135 single plates and sixty folio sheets of text, containing about 500 illustrations—by A. VON SCHWEIGER-LERCHENFELD. Published by A. HARTLEBEN, Vienna, in sixty parts (issued twice a month), at thirty-five cents per part.

Baron VON SCHWEIGER-LERCHENFELD proposes to publish, as above, a folio atlas (about 11½ by 16 inches), to represent the present condition of Celestial Photography—its instruments, methods, and results. The illustrations, over 600 in all, are to be supplemented by the text, also from Baron VON SCHWEIGER-LERCHENFELD'S hand. Modern instruments and observatories are to be represented by some 200 reproductions of photographs furnished to the author by the directors of various American and foreign observatories, or by the instrument-makers who actually constructed the apparatus. A very large proportion of these illustrations is new. Something like a third of the volume is devoted to observatories and instruments. The remaining plates are mostly reproductions of original negatives of the Sun, Moon, planets, comets, meteorites, stars, clusters and nebulæ, etc. (and of their spectra), furnished to the author by the observatories of Mt. Hamilton, Paris, Prague, Potsdam, Heidelberg, etc. A few original astronomical drawings (of *Mars*, etc.) are included for completeness, as well as maps of the stars, planispheres, etc. A circular relating to the atlas was distributed by HARTLEBEN in April last, and it contains plates of the Milky Way (taken at Heidelberg),

* Lick Astronomical Department of the University of California.

the Moon (Paris Observatory), instruments (Pulkowa and Geor town), the Sun (Potsdam and Meudon), *Mars* (drawing Professor HUSSEY at the Lick Observatory), and of the Algei meteorite of 1893 (full size). The illustrations of the atlas very satisfactory, and the descriptions of the text supplem them fully.

Since the foregoing was written, the first part of the A has been received, and it confirms the favorable opinion expres in what precedes. Many of the reproductions are made by half-tone process. When these are compared with the origi negatives, or with direct copies from the negatives, they natur show less fineness and detail. Only a few observatories a astronomers can have access to such originals, however. T present work is intended to meet the wants of the hundreds readers to whom such access must always be closed. Its cl value will be in this regard. Its very complete collection plates relating to instruments will be important to all, proi sionals and amateurs alike. It is now, for the first time, possi for the general reader to possess a work which gives an adequ account of the present state of celestial photography. Throu the kindness of Baron VON SCHWEIGER-LERCHENFELD, seve illustrations from his text are reproduced in the present numbei the *Publications*. It may not be out of place to say that the c of the Atlas, plates, etc., has been some $20,000.

EDWARD S. HOLDEN.

May 10, 1897.

METEOR SEEN AT MT. HAMILTON (MAY 5, 1897).

On the evening of May 5, 1897, at $7^h 30^m$ P. S. T., M NICHOLAS D. SOTO, an employé of the Lick Observatory, cal my attention to a very bright meteor-trail, the remnants of explosion, which Mr. SOTO observed at about $7^h 26^m$. The ge eral direction of the zigzag trail was nearly horizontal (the no end was perhaps 5′ higher than the west end), and about 1° lor It was seen by nearly all the astronomers of the Lick Obser tory. I made two sets of altitude and azimuth determinatic of the brightest portion (extreme west end of the trail) from point near the northeast corner of the main residence buildir

$$\left.\begin{array}{ll}\text{Azimuth of extreme west end, N.} & 51^\circ\ 42'\ \text{W.} \\ \text{Altitude of extreme west end,} & 3\ \ 30\end{array}\right\}\ 7^h\ 39^m.$$

PHOTOGRAPHIC EQUATORIAL OF THE MOSCOW OBSERVATORY.

(Camera-lens, 4 inches aperture; plates about $9\frac{1}{2}$ x $11\frac{1}{2}$ inches; notice that the declination axis is itself a tel[escope] of $2\frac{1}{2}$ inches aperture.)

(Atlas der Himmelskunde.)

Another set of measures, made at $7^h\ 48^m$, gave the same co-ordinates. After $7^h\ 50^m$, the matter became too faint for further measures. The peculiarly vivid whiteness of the meteoric cloud was similar to that of the great meteor of July, 1894.

J. M. SCHAEBERLE.

Lick Observatory, May 6, 1897.

STABILITY OF THE GREAT EQUATORIAL, 1888–1897.

Observations for the position of the great telescope have been made by Messrs. SCHAEBERLE, KEELER, CAMPBELL, TUCKER, and COLTON, as below:—

1888, July 27,	azimuth +36″;	level 8″	too low,
1889, May 18,	" .... ;	" 36	"
Sept. 16,	" +83 ;	" 58	"
1890, Aug. 23,	" (+54);	" 114	"

Telescope adjusted.

1891, June 30,	azimuth .... ;	level 35″	too low.

Holding-down bolts tightened.

1892, Aug. 5,	azimuth +51″;	level 25″	too high,
1893, Sept. 23,	" +48 ;	" 57	too low,
1896, Dec. 5,	" .... ;	" 74	"
1897, Apr. 24,	" +60 ;	" ..	"

E. S. H.

MEASURES OF *PROCYON*,* BY WILLIAM J. HUSSEY.

The following measures of SCHAEBERLE'S companion to *Procyon* have been made with the 36-inch telescope, using a power of 520 . . . :—

1897.072	$p = 319°.23$	$s = 4''.58$
.203	320 .06	4 .77
.206	320 .01	4 .59
1897.16	319°.8	4″.65

REFLECTOR AND PORTRAIT LENS IN CELESTIAL PHOTOGRAPHY.

Those who are interested in the technical points suggested by the above title cannot do better than to refer to a nearly exhaustive discussion of them by Professor MAX WOLF in *Nature* for

* From the *Astronomical Journal*, No. 403.

April 22, 1897, pp. 582–586, and to the illustrations given there. I venture, in this connection, to mention remarks printed in these *Publications*, Vol. III (1891), p. 249, Vol. VI (1894), p. 24, which relate to the problems discussed by Professor WOLF in the paper cited. E. S. H.

DEDICATION OF THE FLOWER OBSERVATORY, UNIVERSITY OF PENNSYLVANIA.

On the afternoon of May 12th took place the exercises which marked the practical completion of the above-named observatory, though observations have been going on regularly there since last October.

The ceremony of the dedication was not elaborate, but all present appear to have found it very enjoyable.

A platform had been erected in front of the equatorial building for the accommodation of the speakers. In front were seated about four hundred invited guests.

Provost C. C. HARRISON, of the University, in a short introductory address, presented the speaker of the day, Professor SIMON NEWCOMB. Provost HARRISON gave a brief outline of the bequest of the founder, REESE WALL FLOWER. This consists of one hundred acres of valuable land adjoining the city of Philadelphia, and upon which the observatory now stands. It is not known how Mr. FLOWER came to make this bequest, as he had never showed any special interest in astronomy.

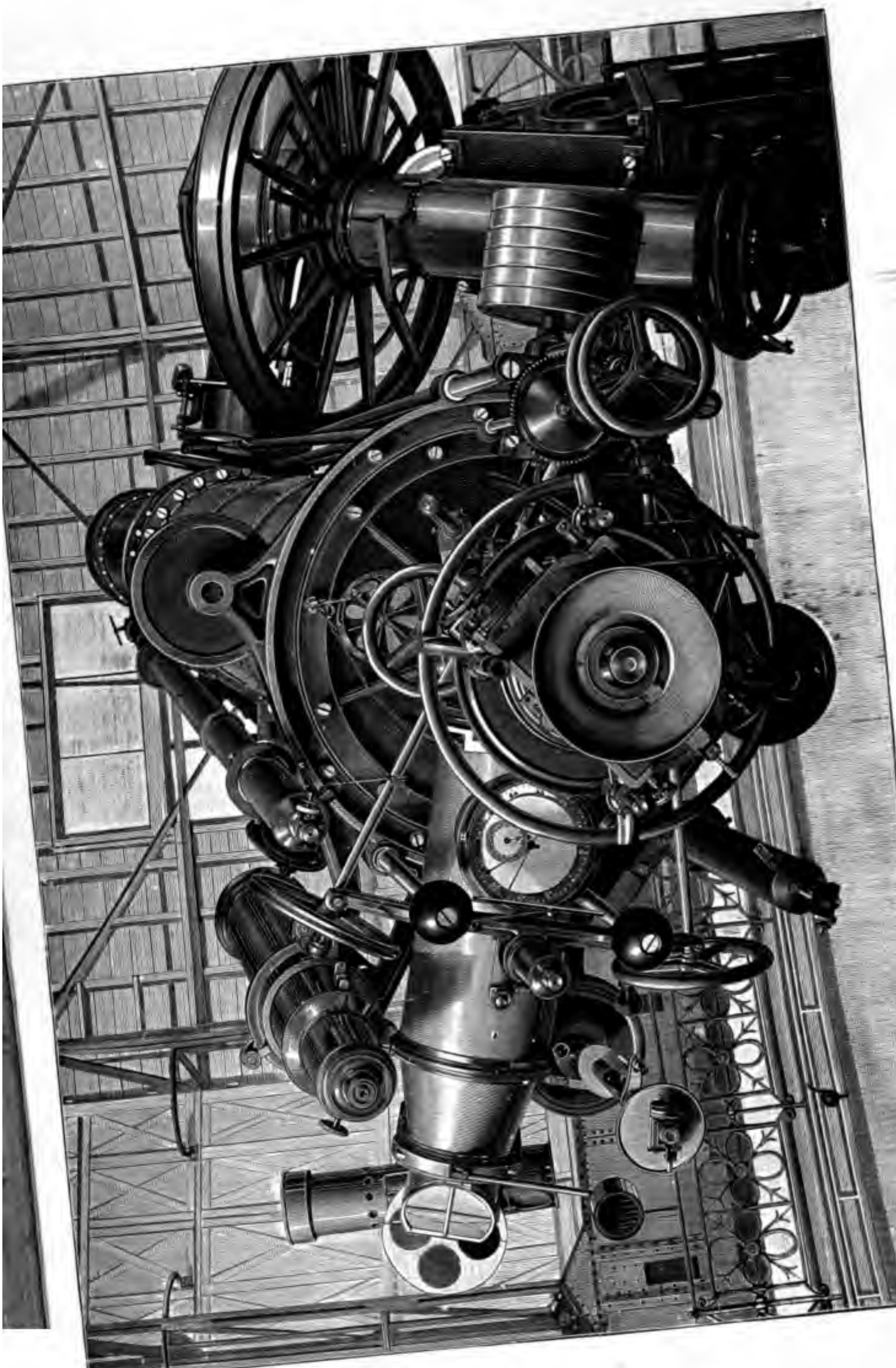
Professor NEWCOMB gave a very interesting paper upon "The Problems of Astronomy," which was followed by short addresses of an informal nature by Dr. W. R. WARNER, Mr. BRASHEAR, Miss PROCTOR, Dr. BARKER, and C. L. DOOLITTLE.

The exercises were followed by a very enjoyable reception at the residence of the Director.

RECORD OF EXPERIMENTS WITH THE MOVING FLOOR OF THE 75-FOOT DOME OF THE LICK OBSERVATORY.

The following summary of experiments with the moving floor of the 75-foot dome may appropriately be recorded here. The original data are scattered in various places, and if brought together, they will be useful in subsequent comparisons.

The idea of a moving floor was first suggested to the Lick Trustees by Sir HOWARD GRUBB, F. R. S. The floor was to rise



16½ feet. Four nuts were fixed to its edge, and four vertical screws in them were to be driven by a three-cylindered water-engine in the basement. The available pressure was only seventy-two pounds per square inch. This plan was tried (against my advice) and failed. The floor never could be made to rise its whole height in less than an hour (approximately). The screws were taken out in May, 1888, and the floor was lifted by four hydraulic jacks. The supply of water to these jacks was regulated by four lock-valves, whose scales were divided into six parts. Up to 1895 these were used ⅙ open.

May 31, 1888.—Floor moves *down* in $5^m\ 45^s$ (16½ feet); *up* in $12^m\ 0^s$. Five hundred pounds were then added to the counter-weights.

June 15, 1888.—Floor moves *down* in $5^m\ 33^s$; *up* in $7^m\ 43^s$.

Experiments between 1888 and 1895 are not here set down.

August 28, 1895.—Valves ⅙ open; the floor moves *down* in $5^m\ 42^s$; *up* in $9^m\ 30^s$. The heavy mahogany chair (needed in most photographic work) was then removed from the floor. The floor moved *down* in $6^m\ 40^s$; *up* in $9^m\ 10^s$. About this time the capacity of the waste pipes from the jacks was increased. The capacity of the supply pipe should also be increased, but it has not been done, on account of the expense.

August 19, 1896.—Valves wide open; floor moves *down* in $5^m\ 20^s$; *up* in $10^m\ 30^s$.

April 29, 1897.—Added 592 pounds of lead to the counter-weights of the moving floor. The valves were 3/6 open. After adding the extra weights, the floor moved *down* in $6^m\ 30^s$, and *up* in $9^m\ 20^s$. The valves were then opened wide, and the floor moved *down* in $5^m\ 5^s$; *up* in $9^m\ 30^s$. The valves were left wide open. The packing of the rams will account for small differences in time, according as it is tight or loose. The jacks, on the whole, do not work as efficiently in 1897 as in 1888. This is probably due to the fact that they are not absolutely vertical, especially in the upper eight feet of their play. One single ram of the proper length would have been a better device than the present telescopic arrangement. All the other machinery of the moving floor (see *Engineering*, Vol. 46, p. 204, 1888) is now in excellent order.

EDWARD S. HOLDEN.

April 30, 1897.

Statistics of the Library of the Lick Observatory.

A count, made on May 31, 1897, of the books and pamphlets in the library of the Lick Observatory, shows—

4121 books,
3912 pamphlets,

as against

2885 books,
3343 pamphlets,

in March, 1892.

A comparison of the two counts of pamphlets is classified below:—

PAMPHLETS.

Drawer.	March, 1892.	May, 1897.
1. Mathematics	51	87
2. Mathematical Tables	1	4
3. Cosmology	52	74
4. Spherical Astronomy	16	19
5. Theoretical Astronomy	73	113
6. Theory of Instruments	78	63*
7. Chronology	6	33
8. Catalogues of Stars	56	49*
9. Ephemerides	26	91*
10. Astronomical Tables	31	46*
11. Geodesy	55	33*
12. Determination of Geographical Positions	55	110*
13. Metrology	16	27
14. Earthquakes, and Geography	75	67*
15. Refraction	6	8*
16. Sun, Zodiacal Light	103	73*
17. Solar Eclipses	97	60*
18. Moon	72	86*
19. Transits of Interior Planets	51	24*
20. Planets and Satellites	99	91*
21. Fixed Stars	17	21*
22. New and Variable Stars	30	36*
23. Double Stars	55	33*
24. Nebulæ	53	76*
25. Obliquity, etc.	14	22*
26. Proper Motions	30	2*
27. Observatories, Reports of	121	243*
28. Miscellaneous Astronomical Observations	70	120*
29. Chemistry and Mechanics	11	37
30. Heat, Sound, Electrics	73	150
31. Optics, etc.	73	43*
32. Meteorology	109	32*
33. Meteorological Observations	166	8*
34. History of Astronomy	157	183*
35. Astronomical Biography	156	87*
36. Astronomical Bibliography	124	133*
37. Comets and Meteors	161	72*
38. Spectroscopy	58	62*
39. Photography	109	144
40. Star Maps	31	26*
41. Geography and Maps	69	67*
42. Time Service	77	87
43. Price Lists of Instruments	144	233*
44. Photographs	158	234
45. History of the Lick Observatory	62	74
46. Catalogues of Colleges	23	92*
47. Miscellaneous	95	170
48. Publishers' Book Lists	78	233
	3343	3878

In addition to the above, I have counted 16 Smithsonian and 18 miscellaneous pamphlets, bringing the total to 3912. Photographs, drawings, maps, and charts are included in both counts.

A large number—not far from 1000, probably,—of pamphlets has been selected from the drawers marked (*), and bound into volumes since the count was made in 1892. Many pamphlets are also sent, from time to time, to the General Library of the University at Berkeley.

R. G. Aitken.

APPARATUS FOR MEASURING PHOTOGRAPHIC PLATES (REPSOLD).

(Atlas der Himmelskunde.)

Post Office at Mt. Hamilton.

The post office at Mt. Hamilton was established in 1890, with Professor S. W. Burnham as postmaster. His successor was Mr. A. L. Colton, the present incumbent. The salary of the postmaster has been a part of the pay of these officers of the observatory. The salary was, for the fiscal year ending

June 30,	1891,	$301.42	June 30,	1894,	$330.86
	1892,	346.10		1895,	341.01
	1893,	285.08		1896,	307.69

E. S. H.

May 31, 1897.

Appointment of Professor Robert G. Aitken as Assistant Astronomer in the Lick Observatory.

At a meeting of the Regents of the University, held May 25, 1897, Professor Robert G. Aitken, B. A. (Williams College, 1887), M. A. (Williams College, 1892), was appointed Assistant Astronomer in the Lick Observatory. Edward S. Holden.

Graduate Students in Astronomy at the Lick Observatory (1897).

The following-named gentlemen have been admitted as special students for the summer of 1897: Professor H. D. Curtis (University of the Pacific), B. A. (Michigan, 1892), M. A. (Michigan, 1893); Professor D. A. Lehman (University of the Pacific), B. S. (State Normal School, Penn., 1889), Ph. B. (Wesleyan, 1893).

Instruments Making in Allegheny.

The following instruments have been made recently by Mr. J. A. Brashear, of Allegheny, or are at present in process of construction at his shops:—

Two 16-inch photographic doublets (Petzval system), for Professor Max Wolf, of the University of Heidelberg.

Eight-inch photographic doublet, with camera, for the University of Tokio. This instrument was shipped in time for use during the total eclipse of August 9, 1896, but observations were prevented by cloudy weather.

Six-inch photographic doublet for Harvard College Observatory. The focal length of the combination is forty-five inches,

and the field is fourteen degrees. According to preliminary tests, this should be a very satisfactory instrument. The star-discs are nearly round, though slightly enlarged at the extreme edge of the field.

Eight-inch visual objective, for Park College, Missouri.

Four-and-one-half-inch equatorial, complete, for the U. S. Military Academy, West Point.

Three 5½-inch reflectors, equatorially mounted, for Messrs. J. M. COOK, of Macon, Georgia, J. R. BETTIS, of St. Louis, and J. O. DEVOR, of Elkhart, Indiana.

Small photographic correcting lens, for spectroscopic work with the 12½-inch equatorial of the Ohio State University.

Concave grating spectroscope, complete, with many accessories, for Dr. HAUSWALDT, of Magdeburg, Germany; for a 6-inch concave grating of twenty-one feet radius.

Star spectroscope, with many accessories, including grating, photographic objectives, and camera, for the 10½-inch equatorial of the University of Minnesota (Professor LEAVENWORTH).

Two large star spectroscopes.

Spectrometer, with prisms and grating, for Mr. C. F. BRUSH, of Cleveland, Ohio, and various smaller pieces of apparatus.

DEATH OF ALVAN G. CLARK.

ALVAN G. CLARK, the last survivor of the famous firm of ALVAN CLARK & SONS, died in Cambridgeport on June 9, 1897, at the age of sixty-five years. The best monuments to the members of this gifted family are the splendid telescopes which they have set up during the last fifty years all over the world, from St. Petersburg to California. E. S. H.

ROYAL OBSERVATORY, GREENWICH, 1896–97.

At the annual visitation of the Royal Observatory, Greenwich, the report of the Astronomer Royal, which refers to the period from May 11, 1896, to May 10, 1897, was submitted. It stated that the building of the north wing and central dome was completed in September last. Under this dome is erected the largest telescope in the world devoted exclusively to photography—the 26-inch refractor, the gift of Sir HENRY THOMPSON. This instrument, completed in April, is already in good working order. On the same mounting is carried the 12¾-inch MERZ

refractor, as a guiding telescope (in years gone by called the Great Equatorial), and the THOMPSON 9-inch photoheliograph; and in place of a counterpoise at the other end of the declination axis, a CASSEGRAIN reflecting telescope of 30-inch aperture, with a new photographic spectroscope attached, and with the 6-inch HODGSON telescope as guiding telescope. The THOMPSON equatorial thus forms a remarkable and powerful combination of telescopes, adapted to visual, photographic, and spectroscopic work, mainly due to private munificence. When the new altazimuth was ready for use in September, it was found that there were serious discordances in the readings of the circles under the different microscopes, depending on the direction in which the instrument was previously turned. Quite recently Mr. SIMMS has discovered an entirely unsuspected source of error. Owing to the method of giving a helical twist to the grinder while grinding the pivots, it was found that the pivots had a tendency to act as a screw, a longitudinal force being set up, the direction of which depended on the direction in which the telescope was turned, the effect of which was to slightly move the iron standards carrying the bearings and the microscopes, and thus to change the position of the microscopes relatively to the graduated circles. This action of the pivots has been cured by a few circular turns of the same tool. With the transit circle the Sun, Moon, planets, and fundamental stars have been regularly observed as in previous years, and the annual catalogue contains 3454 stars. The end of the year 1896 finished the period of observation for the new ten-year catalogue for the epoch 1890, which will comprise the accurate places of some 7000 stars, of which a large number are those previously observed by GROOMBRIDGE, so that good data for proper-motions will be available. For the next ten years the programme of observations with the transit circle will comprise the observations of stars (down to the ninth magnitude inclusive) within twenty-six degrees of the pole, in addition to the usual observations of the Sun, Moon, planets, and fundamental stars.

With the astrographic equatorial half the number of required chart plates and two thirds of the catalogue plates have been obtained. Of the fields still required, 197 are within ten degrees of the pole, and photographs of this part of the sky have been purposely deferred till near the epoch 1900. At the present rate of progress, the whole work will occupy about nine years.

With the 28-inch refractor 195 double stars have been measured, each star on the average on two nights, and the satellite of *Neptune* on four nights. The excellence of this object glass is practically demonstrated by the fact that the actual power of separation by observation of two close stars is greater than the theoretical value, and, curiously enough, the same holds good in the case of the large telescope at the Lick Observatory, a fact which speaks volumes for the instrument-makers. Some photographs of the Moon and close double stars made in the course of the year have likewise demonstrated that the reversal of the crown lens makes this telescope an equally efficient instrument for purposes of photography. With the DALLMEYER photoheliograph the usual Sun photographs have been made, and gaps in the series at Greenwich filled up by photographs from India and Mauritius, so that there are records on 360 days. The spot activity of the Sun has continued to decline since the date of the last report, but has undergone two remarkable cases of temporary revival, the first in September, 1896, when the longest connected group ever photographed at Greenwich was observed, and the second at the commencement of the present year.

During the year under review, the average number of chronometers and deck watches being rated at the observatory was 446; the total number received was 1220, the total number issued 1124, and the number sent for repair 519. For the annual trial of chronometers, which lasted twenty-nine weeks, in temperatures ranging from 42° to 107°, ninety-seven chronometers were entered, and fifty-four of these were purchased by the Admiralty for the navy. The Greenwich time ball was not raised on five days, owing to the violence of the wind, and that at Deal on ten days, for the same reason. The meteorological and magnetical observations have been made as usual. The selection of a site in Greenwich Park for a new magnetic pavilion has caused a good deal of trouble, owing to the difficulty of finding a suitable position, free from any suspicion of disturbance from iron. During the year there were no days of great magnetic disturbances. The rainfall for the year ending April 30, 1897, was 26.83 inches, being 2.29 inches above the fifty years' average. The highest daily temperature in the shade on the open stand was 91°.1, on July 14th; the highest recorded temperature under similar conditions in the preceding fifty-five years was 97°.1, on July 15,

1881.—Condensed from a report in the London *Times*, June 7, 1897.

EXPEDITION FROM THE LICK OBSERVATORY TO OBSERVE THE ECLIPSE OF JANUARY, 1898, IN INDIA.

The total solar eclipse of January, 1898, will be observed by Professor CAMPBELL, of the Lick Observatory, and volunteer assistants. The expedition was authorized by the Regents of the University of California at their meeting of June 23d, and its expenses will be met from a fund generously provided by Colonel C. F. CROCKER, a member of the Regents' Committee on the Lick Observatory.*

The programme of the expedition will be both spectroscopic and photographic. The principal subjects of observation will be:—

1. Photographs of the spectrum of the reversing layer.
2. Spectrum photographs, to determine the velocity of rotation of the corona.
3. Observation 1 repeated with a different instrument.
4. Photographs of the spectrum of the corona.
5. Photographs of the corona on a large scale (40-foot lens), on the plan first employed by Professor SCHAEBERLE in Chile.
6. Photographs of the corona with a portrait lens, on 8 x 10 plates.
7. Photographic photometry of the corona, as in the Lick Observatory expeditions of January and December, 1889, April, 1893, (August, 1896).

It is hoped and expected that this expedition will be favored with good observing weather. EDWARD S. HOLDEN.

MT. HAMILTON, June 24, 1897.

ASTRONOMICAL TELEGRAM.

[TRANSLATION.]

L. O., June 30, 1897; sent 9:50 A. M.

To Harvard College Observatory:—

D'ARREST'S comet was discovered by C. D. PERRINE, June 28.9764 G. M. T.; R. A. $2^h\ 1^m\ 24^s.6$; N. P. D. $89^\circ\ 46'\ 29''$.

[The comet is faint, about 2′ in diameter, with a faint condensation, but no nucleus.]

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* It will be remembered that the Lick Observatory eclipse expeditions to Cayenne (December, 1889) and to Japan (August, 1896) were sent at the expense of Colonel CROCKER.

PHOTOGRAPHIC ATLAS OF THE MOON.

[EXTRACTS FROM A CIRCULAR.]

Based chiefly on focal negatives of the Lick Observatory, to the scale of ten feet to the Moon's diameter; executed by Professor LADISLAS WEINEK, Ph. D., Sc. D., Director of the Imperial and Royal Observatory of Prague. Published by CARL BELLMANN in Prague [price £1 for each part (twenty plates); ten parts will complete the first series].

"My long experience in producing drawings and pictures of lunar landscapes, some with the direct aid of the telescope, others by enlargement from a number of photographic plates of the Lick Observatory, has supplied me with the materials for undertaking the following work, which claims to produce an accurate and artistic representation of the whole visible surface of the Moon.

Dissatisfied with the photographic enlargements made by experts in various quarters, I began, on April 19, 1893, a series of experiments, with a view to discover a method which, while rendering the minutest details with absolute exactness and accuracy, might at the same time ensure a plastically perfect and beautiful delineation of the object portrayed. That method I flatter myself to have now found. I intend to publish, in the immediate future, an account of it.

The materials that form the basis and bulk of the Photographic Lunar Atlas, begun by me in 1894 and now almost completed, are mainly derived from the Lick Observatory. The contributions from that source consist of ninety-four exquisite negatives, including the various phases of a whole lunation, taken at the focus of the telescope of 36-inch aperture of that observatory during the years 1890–1896, and of about 140 diapositives of the same size. To these must be added four striking lunar negatives made by Messrs. LOEWY and PUISEUX at the focus of the large Equatorial Coudé (of 60-*cm* aperture and 18-*m* focal length) of the Paris Observatory, and two excellent lunar diapositives of the Arequipa branch station of the Observatory of Cambridge (Mass.), taken by Professor BAILEY with the telescope of 13-inch aperture, and enlarged with an ocular placed near the focus. Hence, my Photographic Lunar Atlas had to be based essentially on the lunar negatives of the Lick Observatory; whilst the enlargements

of Paris and Arequipa plates are added chiefly for the purpose of facilitating comparative study.

The scale adopted in enlarging the Lick negatives is uniformly twenty-four times the original, whilst the scale of enlargement of the Paris negatives and Arequipa diapositives is slightly less. For the first, the enlargement corresponds, at the mean distance of the Moon from the Earth, to a lunar diameter of 10 feet (= 3, 1 *m*, 1 *mm* = 1, 1 *km* = 0,″6). For the last, the enlargement gives a diameter of 4 metres (1 *mm* = 0,89 *km* = 0,″48) i. e. the double of the diameter of SCHMIDT'S Map. In enlarging the focal plates twenty-four times, one brings out to the naked eye, and without any difficulty, the smallest details of the lunar surface, while its plastic beauty is not altered; and in the second, a simple ratio with the map of SCHMIDT is maintained. The following instance will help to illustrate this remark: On the photographic enlargement (twenty-four times) from a Lick negative, June 27, 1895, 8^h 21^m 1^s, P. S. T., I discovered, on January 10, 1896, on the top of the mountain in the northwestern part of the interior of *Cyrillus*, a small round object like a crater of 1. 1 *km* in diameter. I at once communicated my observation to the French selenographer, C. M. GAUDIBERT, and sent him at the same time the print containing it. On the 20th of January, 1896, he was able to confirm, without any possible doubt, the existence of this crater on that mountain, with his telescope of 260 *mm* aperture. The diameter of that crater is 1 *mm* on the print, and it would hardly be visible to the naked eye were the enlargement made on a smaller scale.

The work of enlarging from the above focal plates went on up to Easter, 1897. From April 19 to December 1, 1893, 100 photo-lunar enlargements were made; most of these are of the size of 13×18 *cm;* and they come from diapositives; they comprise experiments of the utmost variety. From December 1, 1893, up to Easter, 1897, I made 485 photo-lunar enlargements from original negatives only (with the exception of seven enlargements taken from two Arequipa diapositives), and of the size of 21×26 or of 26×31. From among these the first 196 were made by myself, with an assistant for the development of the plates, etc.; the last 289 were executed, since November 1894, by myself alone in all the stages of their execution. The last, mentioned enlargements, based, too, on more favorable original negatives, were the first to give complete satisfaction. Funds to

defray the very considerable outlay for plates in pursuing this lengthy and laborious work were provided, partly by a government grant and a grant from the Vienna Academy of Science, partly by the munificence of private donors, especially Baron ALBERT VON ROTHSCHILD in Vienna, and Miss CATHERINE W. BRUCE in New York.

And now that the principal part of this preparatory work is done, the plan is to publish at Prague a Lunar Photographic Atlas on a scale of ten feet, relatively four metres, to the diameter of the Moon, having 200 maps of the size of 26×31 *cm*, containing the principal lunar formations viewed under the most varied conditions of illumination. If this atlas is favorably received, I propose to publish, later on, a second series of 200 maps, to complete the first. The 200 maps first mentioned come from enlargements made since November, 1894, and show the best of what has been done up to the present time. The order in which the pictures will be arranged must not be supposed to follow the phases of the waxing or waning Moon; it will rather be determined by the degree of excellence or of beauty exhibited in the enlargements available for publication. Shown at the top of each sheet will be the selenographical latitude and longitude for the centre of the picture, and also the selenographical longitude of the terminator for the latitude 0°. By this means it will be easy for every one to arrange the sheets according to the relative positions of the lunar objects they portray, or according to the terminator of the corresponding lunar phase. To secure the utmost precision in the minutest details, the reproductions of enlargements done at Prague will be executed by the phototype process in a manner as closely approaching perfection as possible. They will be printed direct from my enlarged glass diapositives, under my constant personal supervision and control, by the well-known Art-Photographical Institute of CARL BELLMANN, Prague. The enclosed print, showing the Maginus Walled Plain* (L. O. 1895, Oct. 9, $16^h\ 20^m\ 2^s$— $2,^s 5$, P. S. T.), is an example of the way in which each map will be printed on card board of the size of 33×43 *cm*, so that they may be easily handled at the telescope or framed for scientific collections. Each map will be detached, and one fascicle, containing twenty maps, will appear every two—

* The circular is accompanied by a reproduction of Professor WEINEK's enlargement of *Maginus*, which is admirable in every respect. Copies of the circular and this plate will be sent by CARL BELLMAN, as above, to those who apply to him. E. S. H.

three months. This will obviate the difficulty that observatories, academies, scientific societies, and institutions might else find in purchasing the entire work in one issue.

The publication of the atlas in the dimensions proposed (ten issues, making a total of 200 lunar landscapes) cannot be undertaken until the requisite pecuniary support is forthcoming in the shape of promises of numerous subscribers to the work. I venture to appeal in the first instance to the various observatories at home and abroad, and to solicit their promises to become subscribers for the ten issues, each to contain twenty lunar landscapes.

Pursuing, as I do, different ends from those of the Paris Lunar Atlas (its diameter of nearly 2½ metres makes it a little larger than SCHMIDT'S map) which aims at securing great beauty of relief and plastic effect, as well as from those of the Mt. Hamilton Atlas (its diameter is equal to that of MÄDLER'S map, i.e. one metre), which endeavors to preserve the faint contrasts of light and shade in their true value, my enlargements published in the Prague Lunar Atlas should have ample justification for publication, in that they will together afford a faithful and accurate reproduction of the striking results obtained in the field of photo-selenography at the end of the nineteenth century."

PROFESSOR DR. L. WEINEK, Director of the Imperial and Royal Observatory of Prague.

PRAGUE, April 18, 1897.

TRIAL OF THE CROSSLEY REFLECTOR.

At the beginning of April, 1897, Professor HUSSEY was placed in full charge of the CROSSLEY reflector, to give it a thorough trial, visually at the Newtonian focus, and photographically at both the Newtonian and principal foci, thus continuing the work begun by him in June, 1896.* A new driving clock for the instrument has been made by the instrument-maker of the Lick Observatory during the past winter, from drawings by Professor HUSSEY. It is on the same general plan as the driving-clock of the 36-inch equatorial, and promises well. The weights on the double conical pendulum are about twenty-eight pounds each. Mirror A is now in the instrument. During the winter and spring the BRUCE spectrograph has been constructed (at Mount Hamilton)

* See *Publications* A. S. P., Volume VIII, page 236.

for the reflector, from designs by Professor CAMPBELL, who proposes to employ it in the principal focus.

EDWARD S. HOLDEN.

DEATH OF HON. CHARLES FREDERICK CROCKER.

After a short illness, Hon. C. F. CROCKER, Regent of the University of California, and a member of the Committee of the Regents on the Lick Observatory, died at his country place, Uplands, San Mateo County, on Saturday, July 17, 1897, at the age of forty-three years. His loss will be felt in very many relations of business and friendship, and in none more than in those he sustained to the University of California and to the Lick Observatory.

EDWARD S. HOLDEN.

July 18, 1897.

SMALL TELESCOPE FOR SALE.

Mr. C. A. SCRASE (care of Messrs. PERCY & DEARSLEY, 328 Montgomery Street, San Francisco), has in his hands for sale for $130 a telescope of 3¼-inches aperture by E. G. WOOD, of London, complete in its box. Intending purchasers should address themselves to him.

E. S. H.

July 19, 1897.

APPOINTMENTS IN THE LICK OBSERVATORY.

At a meeting of the Regents, July 13, 1897, Mr. WILLIAM H. WRIGHT was appointed to be Assistant Astronomer and Mr. E. F. CODDINGTON to be Fellow in Astronomy.

E. S. H.

MEETING OF THE BOARD OF DIRECTORS AND OF THE SOCIETY, JUNE 12, 1897.

Saturday, June 12th, was the date for a regular meeting of the Directors and of the Society at Mt. Hamilton. As no quorum for the transaction of business (in either body) was present, no meetings were held. The papers presented for reading will be printed in the *Publications* in due course.

OFFICERS OF THE SOCIETY.

Mr. WILLIAM ALVORD	*President*
Mr. EDWARD S. HOLDEN	*First Vice-President*
Mr. FREDERICK H. SEARES	*Second Vice-President*
Mr. CHAUNCEY M. ST. JOHN	*Third Vice-President*
Mr. C. D. PERRINE Mr. F. R. ZIEL	*Secretaries*
Mr. F. R. ZIEL	*Treasurer*

Board of Directors—Messrs. ALVORD, HOLDEN, MOLERA, MORSE, Miss O'HALLORAN, Messrs. PERRINE, PIERSON, SEARES, ST. JOHN, VON GELDERN, ZIEL.

Finance Committee—Messrs. WILLIAM M. PIERSON, E. J. MOLERA, and C. M. ST. JOHN.

Committee on Publication—Messrs. HOLDEN, BABCOCK, AITKEN.

Library Committee—Messrs. HUSSEY and SEARES and Miss O'HALLORAN.

Committee on the Comet-Medal—Messrs. HOLDEN (*ex-officio*), SCHAEBERLE, CAMPBELL.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. RUTHVEN W. PIKE.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. CAMILO GONZALEZ, FRANCISCO RODRIGUEZ REY.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)

ASTRONOMICAL · SOCIETY · OF · THE · PACIFIC ·

PUBLICATIONS

OF THE

Astronomical Society of the Pacific.

VOL. IX. SAN FRANCISCO, SEPTEMBER 1, 1897. NO. 57.

BY-LAWS

OF THE

ASTRONOMICAL SOCIETY OF THE PACIFIC.

ARTICLE I.

This Society shall be styled the ASTRONOMICAL SOCIETY OF THE PACIFIC. Its object shall be to advance the Science of Astronomy, and to diffuse information concerning it.

ARTICLE II.

This Society shall consist of active and life members, to be elected by the Board of Directors.

1. Active members shall consist of persons who shall have been elected to membership and shall have paid their dues as hereinafter provided.

2. Life members shall consist of persons who shall have been elected to life membership and shall have paid $50 (fifty dollars) to the Treasurer of the Society.

3. A certain number of Observatories, Academies of Science, Astronomical Societies, Institutions of Learning, etc., not to exceed one hundred, shall be designated by the Board of Directors as Corresponding Institutions, and they shall receive the publications of this Society in exchange or otherwise.

ARTICLE III.

At each annual election there shall be elected a Board of eleven Directors, and a Committee on Publication, consisting of three members. The officers of this Society shall be a President, three Vice-Presidents, two Secretaries and a Treasurer. The

Directors shall organize immediately after their election, and elect from their number the officers of the Society. They may also appoint a Librarian, and such other assistants as may be required. The Directors shall fill by appointment any vacancies which may occur after the annual election.

The Library of the Society shall be kept in San Francisco, and shall be open to the use of all the members.

ARTICLE IV.

The President, or, in his absence, one of the three Vice-Presidents, or, in the absence of both the President and the Vice-Presidents, any member whom the Society may appoint, shall preside at the meetings of the Society. It shall be the duty of the President to preserve order, to regulate the proceedings of the meetings, and to have a general supervision of the affairs of the Society. The President is, *ex-officio*, a member of all Committees of the Board of Directors.

ARTICLE V.

The Secretaries shall keep, and have the custody of, the records; they shall have the custody of all other property of the Society, excepting the money thereof; they shall give timely notice of the time and place of meetings; they shall keep in books a neat and accurate record of all orders and proceedings of the Society, and properly index them; they shall conduct the correspondence of the Society; they shall preserve and index the originals of all communications addressed to the Society; and keep a copy of all their letters, properly indexed; and they shall prepare for publication an accurate summary of the transactions of the Society at each of its meetings.

ARTICLE VI.

The Treasurer shall receive and deposit in such bank as may be designated by the Directors, to the credit of the Society, all donations and bequests of money and all other sums belonging to the Society. He shall keep an account of all money received and paid by him, and at the annual meetings shall render a particular statement of the same to the Society. Money shall be paid by him only on the written order of the Finance Committee of the Board of Directors. He shall give such bonds as may be required by the Board of Directors.

ARTICLE VII.

Candidates for active or life membership may be proposed by any member of the Society to either of the Secretaries, in writing. A list of such candidates shall be certified to the Board of Directors by the Secretaries at each of their meetings, in writing. A majority (not less than three) of the Directors present at any such meeting shall be required for election.

ARTICLE VIII.

Each active member shall pay an annual subscription of five dollars, due on the first of January of each year, in advance. Each active member shall, on his election, pay into the Treasury of this Society the sum of five dollars, which shall be in lieu of the annual subscription to the first of January following his election, and in lieu of an initiation fee. No one shall be deemed an active member, or receive a diploma, until he has signed the register of members, or accepted his election to membership in writing, and paid his dues for the current year. Any member may be released from annual dues by the payment of fifty dollars at one time, and placed on the roll of life members by the vote of the Board of Directors. Any failure on the part of a member to pay his dues within six months after the time the same shall have become payable, shall be considered equivalent to a resignation.

ARTICLE IX.

The annual meeting of this Society shall be held on the last Saturday in March, at eight o'clock P. M., at the rooms of the Society in San Francisco; and meetings shall be held for the ordinary transactions and purposes of the Society, as follows:—

Meetings shall be held in the Library of the Lick Observatory, Mount Hamilton, at a suitable hour on the second Saturday of June and the first Saturday of September; and meetings shall be held in the rooms of the Society, in San Francisco, at eight o'clock P. M., on the last Saturdays of January, March, and November.

A special meeting may be called by the President, or, in his absence or disability, by one of the Vice-Presidents, or, in the absence or disability of both the President and the Vice-Presidents, by the Secretary, on the written requisition of ten active or life members; and the object of such meeting shall be stated in the notice by which it is called.

The annual election shall be held on the day of the annual meeting, between the hours of 8:15 and 9 P. M.

No member shall be permitted to vote at any meeting of the Society who has not paid all his dues for past and current years. There shall be no voting by proxy.

ARTICLE X.

Fifteen active or life members shall be a quorum for the transaction of business.

ARTICLE XI.

No papers or manuscripts shall be published by the Society without the consent of the Directors. Any motion to print an address, or other paper read before the Society, or any other matter belonging to the Society, shall be referred to the Committee on Publication, who shall report to the Directors. The Committee on Publication may make suggestions to the Directors, from time to time, with reference to the publication of such papers as in their judgment should be published by the Society; and this Committee shall have the care, direction and supervision of the publication of all papers which the Directors may authorize to have published.

Members of the Society shall receive all the publications of the Society free of charge.

ARTICLE XII.

This Society may, by a vote of a majority of all its active and life members, become a branch of an American Astronomical Society, should one be formed.

ARTICLE XIII.

It shall be the duty of the Directors, in case any circumstances shall arise likely to endanger the harmony, welfare or good order of the Society, to call a special meeting of the Society; and if, at such meeting, after an examination of the charges, and hearing the accused, who shall have personal notice of such proceedings, it shall be proposed that the offending member or members shall be expelled, a vote by ballot shall be taken, and if two thirds of the members present vote in favor thereof, the offending member or members shall be expelled.

ARTICLE XIV.

The Directors shall meet half an hour before the stated time of each bi-monthly meeting, and at such other times as they may appoint. The President, or, in his absence, any one of the Vice-Presidents, may call special meetings of the Board of Directors at any time. Notice of the time and place of such meeting shall be given by the Secretaries, by depositing in the post-office at San Francisco a notice of the time and place, addressed to each Director personally, at his last known place of residence, with the postage thereon prepaid, six days before the time of meeting.

ARTICLE XV.

The By-Laws may be amended at any time by a consenting vote of nine members of the Board of Directors at any duly called meeting thereof.

ARTICLE XVI.

In order to increase the usefulness of the Society, any groups of its members residing in the same neighborhood (except in the City and County of San Francisco, State of California,) are authorized to form local organizations which shall be known as "The ——— Section of the Astronomical Society of the Pacific."

No Section shall be formed except by the consent of the Board of Directors of the parent Society.

The proceedings of such Sections may be printed in the Publications of the Astronomical Society of the Pacific, either in full or in abstract, and the parent Society shall not be in any way responsible for publications made elsewhere.

No person not a member of this Society in good standing shall be eligible to membership in a Section, nor shall membership in a Section interfere in any way with the status of the person as a member of this Society.

The special expenses of each Section shall be borne by the group of members composing it, and this Society shall not be liable for any debts incurred by any Section.

STATUTES FOR THE BESTOWAL OF THE BRUCE MEDAL OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.

. I. A medal is founded by Miss Catherine Wolfe Bruce of New York, to be given, not oftener than once a year, for distinguished services to astronomy. The medal is international in character, and it may be awarded to a citizen of any country, and to a person of either sex.

II. The cost of the medal is to be met from the interest of the *Bruce Medal Fund* of $2500. The capital of this fund is not to be impaired. Unexpended interest is to be added to the capital to become an integral part thereof.

III. The medal is to be of gold. The *obverse* is to bear the Seal of the Astronomical Society of the Pacific. The *reverse* is to bear an inscription as follows: This medal, founded A. D. MDCCCXCVII, by Catherine Wolfe Bruce, is presented to .... for distinguished services to Astronomy .... (date in years).

IV. The Bruce Medal is not to be given twice to the same individual.

V. On the first of September of every year one of the Secretaries of the Astronomical Society of the Pacific is to address an official letter to the Director of each of the following Observatories, namely:—

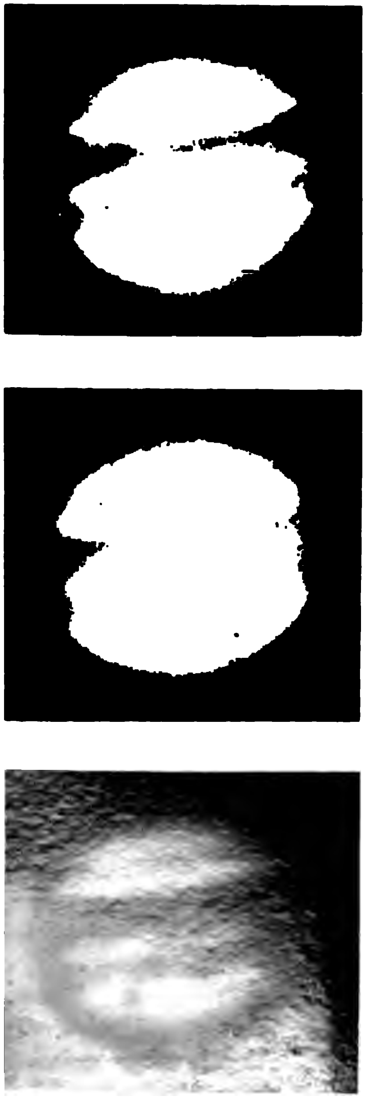
The Harvard College Observatory,	The Observatory of Paris,
The Lick Observatory,	The Observatory of Greenwich,
The Yerkes Observatory,	The Observatory of Berlin,

enclosing the statutes relating to the Bruce Medal, and requesting each of the six Directors just named to nominate not to exceed three Astronomers worthy to receive the medal for the ensuing year.

The replies of the said Directors are not to be communicated by the Secretary to any person until the first of November, when a list containing the names of the Astronomers so nominated is to be certified, in writing, by the Secretary, to each of the eleven Directors of the Astronomical Society of the Pacific; and a special meeting of the Directors called for the last Saturday in November, at 2 P. M. At that meeting these Statutes are to be read; and the original letters from the Directors of the Observa-

be awarded (unless under the most exceptional circumstances) for the discovery of a comet until enough observations are secured (by the discoverer or by others) to permit the calculation and verification of its orbit.

V. This medal is to be a perpetual foundation from and after January 1, 1890.



JUPITER, MARCH 22, 1897.

(Taken at the Lick Observatory with an 18-inch Reflecting Telescope.)

Exposure Times	8^h	22^m	0^s to 40^s	P. S. T.
	10	11	0 to 40	
	10	16	0 to 40	

PUBLICATIONS

OF THE

Astronomical Society of the Pacific.

Vol. IX. San Francisco, October 1, 1897. No. 58.

PHOTOGRAPHS OF *JUPITER*.

[Taken with an 18-inch Reflecting Telescope.]

By J. M. Schaeberle.

The three silver prints of *Jupiter* given in the present number are contact copies of negatives taken with the 18-inch reflecting telescope described in Volume VII of these *Publications*. The particular secondary for focal images of this scale can only be used advantageously when there is no wind and when the seeing is first-class. The equivalent focal length, corresponding to the linear dimension of the image, is about 650 feet.

Held at a distance of ten inches from the eye, the effect, so far as simple magnification is concerned, is the same as a view of *Jupiter* through a telescope magnifying 780 diameters. With such a power, the visual observations of planetary details are ordinarily unsatisfactory; in view, therefore, of the improvement (mentioned farther on) in the definition of the 18-inch mirror, which will surely result from the increase in the principal focal length, these photographs are of peculiar interest.

I recently discovered a most serious optical defect which is common to all parabolic mirrors.* The magnitude of this defect increases rapidly as the angular aperture of the mirror increases. In order to obtain results which are not seriously affected by this error, the ratio of focal length to aperture should never be less than, say, fourteen to one. I have decided to regrind and refigure the 18-inch reflector, and make the ratio of focal length to aperture about twice as great as it is at present.

* See *Astronomical Journal*, No. 413.

The silver prints were made by Mr. WILLIAM PAULI of the Lick Observatory. Much of the detail in the original negative is, of course, lost in the paper prints. By comparing the three photographs, allowing for the rotation of the planet, no mistake can be made as to whether a given marking actually corresponds to a surface feature of the planet, or whether it is due simply to a defect in the plate. J. M. SCHAEBERLE.

LICK OBSERVATORY, University of California,
September 20, 1897.

PLANETARY PHENOMENA FOR SEPTEMBER, OCTOBER, NOVEMBER AND DECEMBER, 1897.

By PROFESSOR MALCOLM MCNEILL.

SEPTEMBER.

The Sun crosses the equator and autumn begins at about 11 A.M., P. S. T., on September 22d.

Mercury is an evening star at the beginning of the month, having passed greatest east elongation on August 26th, but it is too near the Sun for naked-eye observations, and passes inferior conjunction on the morning of September 22d. It then becomes a morning star and moves rapidly away from the Sun, so that by the end of the month it rises more than an hour before sunrise, and can be easily seen under good-weather conditions. It is in conjunction with *Jupiter* on September 27th, but the conjunction is not so close, nor are the planets as well situated as they will be at the conjunction which will take place in October.

Venus is a morning star, rising about three hours before sunrise. During the month it moves thirty-six degrees east and nine degrees south through the constellations *Cancer* and *Leo*. On the night of September 24–25th it is very near the first magnitude star *Regulus* (*a Leonis*), passing the star on the north at a distance of about half of the Moon's diameter.

Mars is still an evening star, but it is rapidly nearing conjunction with the Sun, and it can scarcely be seen without telescopic aid, except perhaps during the first few days of the month, when it sets about two hours after sunset. It is also nearly at its greatest distance from the Earth, and least brilliancy. It moves

about eighteen degrees east and eight degrees south through the constellations *Leo* and *Virgo.*

Jupiter comes to conjunction with the Sun on the night of September 12–13th, and becomes a morning star; but does not get far enough away to become visible to the naked eye until nearly the end of the month.

Saturn is still in sight as an evening star, but is nearing the Sun. By the end of the month it sets before 8 P.M. It moves about two degrees eastward during the month along the borders of the constellations *Libra* and *Scorpio.* The rings are nearly at their maximum opening.

Uranus is near *Saturn*, about two degrees south at the beginning of the month, and is also moving eastward, but only about half as fast as *Saturn.* It is so near the horizon after sunset that the conditions for visibility are not good.

Neptune is in the constellation *Taurus*, rising quite late in the evening and is too faint to be seen with the naked eye.

OCTOBER.

Mercury is a morning star throughout the month, and during nearly the whole time is in good position for observation in the twilight just before sunrise. It comes to its greatest west elongation on the evening of October 7th, and at that time rises more than an hour and twenty minutes before sunrise. On the morning of October 6th it is very close to *Jupiter*, conjunction occurring at midnight, P. S. T. At the time of nearest approach, the planets are only twelve minutes of arc apart, a distance much less than the semi-diameter of the Moon, and they will show as a fine double star to the naked eye.

Venus is also a morning star, a little nearer the Sun than it was during September. It moves thirty-four degrees east and sixteen degrees south through the constellations *Leo* and *Virgo.* On the afternoon of October 19th it is in conjunction with *Jupiter*, the nearest approach being a little less than the Moon's diameter, *Venus* being twenty-eight minutes north.

Mars is still an evening star, but closer to the Sun than it was in September. It is now only about as bright as the pole star and cannot readily be seen after sunset. During the latter half of the month it reaches its greatest distance from the Earth, about 236,000,000 miles, a distance a little greater than the average maximum distance, and not quite seven times as great as the least possible distance at opposition.

Jupiter is a morning star, rising about two hours earlier than during the corresponding period in September. It moves about four degrees east and south in the western part of the constellation *Virgo*. Its conjunctions with *Mercury* and *Venus* have already been noted.

Saturn is an evening star, nearer the Sun than it was in September, and by the end of the month it will not be an easy object for the naked eye after sunset. It is moving eastward, near the boundary of *Libra* and *Scorpio*.

Uranus is still near *Saturn*, and is also moving eastward, but at a much smaller rate. At the end of the month it is about three degrees west and one degree south of *Saturn*.

Neptune is in about the same position in the eastern part of *Taurus*, as in September.

Occultation of the Pleiades. The Moon will again pass over the *Pleiades* group on the evening of October 13th. As the Moon is then three days after full, the immersions will occur at the bright limb and the emersions at the dark. The eastern part of the United States is better situated than the western for seeing this group of occultations, as the Moon will have passed over a considerable part of the group when it rises in the Pacific States.

NOVEMBER.

Mercury is a morning star quite near the Sun until November 7th, when it comes to superior conjunction with the Sun, and is an evening star for the rest of the month, but does not get far enough away to be easily visible. It is in conjunction with *Mars* on November 12th, with *Uranus* on November 16th, and with *Saturn* on November 18th, but the planets are all too near the Sun for naked-eye observations.

Venus is still a morning star, but it is gradually drawing nearer the Sun, and at the end of the month rises only about an hour and a half earlier. During the month it moves thirty-six degrees eastward and thirteen degrees southward through the constellations *Virgo* and *Libra*, passing four degrees north of *Spica* (α *Virginis*) on the morning of November 7th, and about one degree north of α *Libræ* on the morning of November 25th.

Mars is too near the Sun for observation throughout the month. It comes to conjunction on the morning of November 21st, and changes from an evening to a morning star, moving about twenty-two degrees eastward and southward during the month.

It is in conjunction with *Mercury*, on November 12th, with *Uranus* on November 21st, and with *Saturn* on November 27th. It reached its greatest distance from the Earth toward the end of October, about a month before the time of conjunction.

Jupiter is a morning star, gradually increasing its distance from the Sun and rising earlier. During the month it moves about five degrees eastward and southward in the western part of the constellation *Virgo*. On the morning of November 15th it passes the fourth magnitude star η *Virginis*, the planet being about half of the Moon's apparent diameter south of the star.

Saturn is quite close to the Sun coming to conjunction, and changing from an evening to a morning star on the night of November 24–25th. It moves about four degrees eastward in the constellation *Libra*. It is in conjunction with *Mercury* on November 18th, and with *Mars* on November 27th.

Uranus is near *Saturn*, three degrees to five degrees west, and comes to conjunction with the Sun on the morning of November 21st. It comes to conjunction with *Mars* one hour later, and *Mars*' conjunction with the Sun occurs only three hours later than his conjunction with *Uranus*.

Neptune is retrograding (moving westward) in the constellation *Taurus*.

DECEMBER.

The Sun enters the sign *Capricorn* (not the constellation), and winter begins December 21st, 5 A.M., P. S. T.

Mercury is an evening star, and after the first few days of the month sets more than an hour after sunset, so that it can be seen under good weather conditions during the greater part of the month. It reaches greatest eastern elongation on December 20th, and then sets about an hour and half after sunset.

Venus is still a morning star, but is drawing nearer to the Sun, and by the end of the month it rises less than an hour before sunrise. It moves about forty degrees eastward and seven degrees southward during the month through the constellations *Libra* and *Scorpio*. At the end of the month it is very close to *Mars*, the planets coming to conjunction on the evening of December 30th.

Mars is a morning star, and by the end of the month rises almost an hour before sunrise, but it is still too faint to be easily seen, on account of its great distance from the Earth. Its brightness will keep on increasing throughout the whole of 1898.

Jupiter is also a morning star. Its distance from the Sun is increasing, and by the end of the month it rises at about midnight. It moves about three degrees eastward in the western part of the constellation *Virgo*.

Saturn is also a morning star, and during the month it gets far enough away from the Sun to be seen in the morning twilight. It is in the western part of the constellation *Scorpio*, and moves about three degrees eastward during the month.

Uranus is also a morning star about five degrees west of *Saturn*, in the constellation *Scorpio*.

Neptune is in opposition on the evening of December 12th.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

Phases of the Moon, P. S. T.

			H. M.
First Quarter,	Sept.	3,	3 13 P. M.
Full Moon,	Sept.	10,	6 12 P. M.
Last Quarter,	Sept.	18,	6 51 P. M.
New Moon,	Sept.	26,	5 46 A. M.

The Sun.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	10 43	+ 8 6	5 33 A.M.	NOON.	6 27 P.M.
11.	11 19	+ 4 22	5 43	11 57 A.M.	6 11
21.	11 55	+ 0 30	5 52	11 53	5 54
Oct. 1.	12 31	− 3 24	6 1	11 50	5 39

Mercury.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	12 16	− 5 5	7 49 A.M.	1 32 P.M.	7 15 P.M.
11.	12 24	− 7 1	7 24	1 0	6 36
21.	11 58	− 3 8	6 5	11 55 A.M.	5 45
Oct. 1.	11 37	+ 2 37	4 46	10 55	5 4

Venus.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	8 9	+ 19 29	2 21 A.M.	9 25 A.M.	4 39 P.M.
11.	8 58	+ 17 11	2 34	19 34	4 34
21.	9 45	+ 14 4	2 55	9 43	4 31
Oct. 1.	10 32	+ 10 16	3 15	9 50	4 25

Mars.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	12 17	− 1 12	7 37 A.M.	1 33 P.M.	7 29 P.M.
11.	12 41	− 3 52	7 31	1 18	7 5
21.	13 5	− 6 30	7 24	1 2	6 40
Oct. 1.	13 30	− 9 6	7 19	12 48	6 17

Jupiter.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	11 18	+ 5 38	6 15 A.M.	12 34 P.M.	6 53 P.M.
11.	11 26	+ 4 48	5 47	12 3	6 19
21.	11 34	+ 3 57	5 19	11 32 A.M.	5 45
Oct. 1.	11 42	+ 3 7	4 50	11 0	5 10

Saturn.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	15 33	− 17 11	11 49 A.M.	4 49 P.M.	9 49 P.M.
11.	15 35	− 17 22	11 13	4 12	9 11
21.	15 38	− 17 34	10 36	3 35	8 34
Oct. 1.	15 42	− 17 48	10 2	3 0	7 58

Uranus.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	15 32	− 18 55	11 55 A.M.	4 48 P.M.	9 41 P.M.
11.	15 33	− 18 59	11 16	4 9	9 2
21.	15 35	− 19 5	10 39	3 32	8 25
Oct. 1.	15 37	− 19 11	10 1	2 54	7 47

Neptune.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	5 27	+ 21 53	11 22 P.M.	6 41 A.M.	2 0 P.M.
11.	5 28	+ 21 53	10 42	6 1	1 20
21.	5 28	+ 21 53	10 4	5 23	12 42
Oct. 1.	5 28	+ 21 52	9 24	4 43	12 2

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Sept. 2.	12 41 A. M.	Sept. 19.	5 35 A.
4.	9 30 P. M.	22.	2 24 A.
7.	6 19 P. M.	24.	11 12 P.
10.	3 8 P. M.	27.	8 1 P.
13.	11 57 A. M.	30.	4 50 P.
16.	8 46 A. M.		

Phases of the Moon, P. S. T.

		H. M.
First Quarter,	Oct. 2,	9 31 P. M.
Full Moon,	Oct. 10,	8 42 A. M.
Last Quarter,	Oct. 18,	1 9 P. M.
New Moon,	Oct. 25,	3 28 P. M.

The Sun.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Oct. 1.	12 31	− 3 24	6 1 A.M.	11 50 A.M.	5 39 P.
11.	13 8	− 7 14	6 12	11 47	5 22
21.	13 45	− 10 54	6 23	11 45	5 7
31.	14 24	− 14 18	6 33	11 44	4 55

Mercury.

Oct. 1.	11 37	+ 2 37	4 46 A.M.	10 55 A.M.	5 4 P.
11.	12 7	+ 1 16	4 51	10 46	4 59
21.	13 4	− 4 56	5 21	11 4	4 47
31.	14 6	− 11 51	6 7	11 26	4 45

Venus.

Oct. 1.	10 32	+ 10 16	3 15 A.M.	9 50 A.M.	4 25 P.
11.	11 18	+ 5 57	3 37	9 57	4 17
21.	12 3	+ 1 18	3 59	10 3	4 7
31.	12 49	− 3 29	4 20	10 9	3 58

Mars.

Oct. 1.	13 30	− 9 6	7 19 A.M.	12 48 P.M.	6 17 P.
11.	13 55	− 11 37	7 14	12 34	5 54
21.	14 22	− 14 0	7 9	12 21	5 33
31.	14 49	− 16 15	7 6	12 9	5 12

Jupiter.

Oct. 1.	11 42	+ 3 7	4 50 A.M.	11 0 A.M.	5 10 P.
11.	11 50	+ 2 17	4 21	10 29	4 37
21.	11 57	+ 1 29	3 52	9 57	4 2
31.	12 5	+ 0 43	3 23	9 25	3 27

Saturn.

Oct. 1.	15 42	− 17 48	10 2 A.M.	3 0 P.M.	7 58 P.
11.	15 46	− 18 2	9 27	2 24	7 21
21.	15 50	− 18 17	8 53	1 49	6 45
31.	15 55	− 18 32	8 19	1 14	6 9

URANUS.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Oct. 1.	15 37	− 19 11	10 1 A.M.	2 54 P.M.	7 47 P.M.
11.	15 39	− 19 18	9 25	2 17	7 9
21.	15 41	− 19 25	8 49	1 40	6 31
31.	15 43	− 19 34	8 12	1 3	5 54

NEPTUNE.

Oct. 1.	5 28	+ 21 52	9 24 P.M.	4 43 A.M.	12 2 P.M.
11.	5 28	+ 21 52	8 45	4 4	11 23 A.M.
21.	5 27	+ 21 51	8 5	3 24	10 43
31.	5 26	+ 21 50	7 25	2 44	10 3

MINIMA OF *ALGOL*, P. S. T.

	H. M.		H. M.
Oct. 3.	1 39 P. M.	Oct. 20.	6 32 P. M.
6.	10 27 A. M.	23.	3 21 P. M.
9.	7 16 A. M.	26.	12 10 P. M.
12.	4 5 A. M.	29.	8 58 A. M.
15.	12 5 A. M.	Nov. 1.	5 47 A. M.
17.	9 43 P. M.		

PHASES OF THE MOON, P. S. T.

		H. M.
First Quarter,	Nov. 1,	6 37 A. M.
Full Moon,	Nov. 9,	1 50 A. M.
Last Quarter,	Nov. 17,	6 2 A. M.
New Moon,	Nov. 24,	1 20 A. M.
First Quarter,	Nov. 30,	7 14 P. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Nov. 1.	14 28	− 14 37	6 34 A.M.	11 44 A.M.	4 54 P.M.
11.	15 8	− 17 35	6 45	11 44	4 43
21.	15 49	− 20 3	6 57	11 46	4 35
Dec. 1.	16 32	− 21 54	7 8	11 49	4 30

MERCURY.

Nov. 1.	14 13	− 12 31	6 11 A.M.	11 28 A.M.	4 45 P.M.
11.	15 15	− 18 25	6 57	11 52	4 47
21.	16 20	− 22 49	7 39	12 17 P.M.	4 55
Dec. 1.	17 26	− 25 19	8 17	12 44	5 11

VENUS.

Nov. 1.	12 54	− 3 58	4 22 A.M.	10 9 A.M.	3 56 P.M.
11.	13 40	− 8 40	4 46	10 16	3 46
21.	14 28	− 13 5	5 10	10 25	3 40
Dec. 1.	15 17	− 16 58	5 33	10 34	3 35

Mars.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Nov. 1.	14 52	− 16 28	7 4 A.M.	12 7 P.M.	5 10 P.
11.	15 20	− 18 29	7 1	11 56 A.M.	4 51
21.	15 49	− 20 15	6 58	11 46	4 34
Dec. 1.	16 19	− 21 44	6 55	11 37	4 19

Jupiter.

Nov. 1.	12 5	+ 0 39	3 19 A.M.	9 21 A.M.	3 23 P.
11.	12 12	− 0 4	2 49	8 49	2 49
21.	12 18	− 0 43	2 18	8 16	2 14
Dec. 1.	12 24	− 1 18	1 46	7 42	1 38

Saturn.

Nov. 1.	15 55	− 18 34	8 16 A.M.	1 11 P.M.	6 6 P.
11.	16 0	− 18 49	7 42	12 36	5 30
21.	16 5	− 19 3	7 9	12 2	4 55
Dec. 1.	16 10	− 19 17	6 35	11 27 A.M.	4 19

Uranus.

Nov. 1.	15 44	− 19 34	8 8 A.M.	12 59 P.M.	5 50 P.
11.	15 46	− 19 42	7 32	12 22	5 12
21.	15 49	− 19 51	6 57	11 46 A.M.	4 35
Dec. 1.	15 51	− 19 59	6 20	11 9	3 58

Neptune.

Nov. 1.	5 26	+ 21 50	7 26 P.M.	2 44 A.M.	10 2 A.
11.	5 25	+ 21 49	6 46	2 4	9 22
21.	5 24	+ 21 48	6 5	1 23	8 41
Dec. 1.	5 23	+ 21 47	5 24	12 42	8 0

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off left-hand limb as seen in an inverting telescope.)

		H. M.			H. M.
I, D,	Nov. 2.	6 43 A. M.	I, D,	Nov. 11.	3 4 A.
IV, D,	4.	12 45 A. M.	I, D,	18.	4 57 A.
I, D,	4.	1 11 A. M.	I, D,	19.	11 26 P.
IV, R,	4.	3 24 A. M.	II, D,	21.	6 48 A.
III, D,	4.	6 35 A. M.	I, D,	25.	6 51 A.
II, D,	7.	1 39 A. M.	I, D,	27.	1 19 A.

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Nov. 1.	5 47 A. M.	Nov. 18.	10 41 A.
4.	2 36 A. M.	21.	7 30 A.
6.	11 25 P. M.	24.	4 19 A.
9.	8 14 P. M.	27.	1 7 A.
12.	5 3 P. M.	29.	9 56 P.
15.	1 52 P. M.		

PHASES OF THE MOON, P. S. T.

		H. M.
Full Moon,	Dec. 8,	8 54 P. M.
Last Quarter,	Dec. 16,	8 22 P. M.
New Moon,	Dec. 23,	11 55 A. M.
First Quarter,	Dec. 30,	11 27 A. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Dec. 1.	16 32	− 21 54	7 8 A.M.	11 49 A.M.	4 30 P.M.
11.	17 15	− 23 4	7 17	11 54	4 31
21.	18 0	− 23 27	7 24	11 59	4 34
31.	18 44	− 23 4	7 36	12 3 P.M.	4 40

MERCURY.

Dec. 1.	17 26	− 25 19	8 17 A.M.	12 44 P.M.	5 11 P.M.
11.	18 32	− 25 32	8 46	1 11	5 36
21.	19 27	− 23 26	8 51	1 26	6 1
31.	19 38	− 20 29	8 10	12 57	5 44

VENUS.

Dec. 1.	15 17	− 16 58	5 33 A.M.	10 34 A.M.	3 35 P.M.
11.	16 8	− 20 6	5 57	10 46	3 35
21.	17 1	− 22 18	6 20	11 0	3 40
31.	17 56	− 23 24	6 40	11 15	3 50

MARS.

Dec. 1.	16 19	− 21 44	6 55 A.M.	11 37 A.M.	4 19 P.M.
11.	16 50	− 22 54	6 51	11 28	4 5
21.	17 22	− 23 40	6 48	11 21	3 54
31.	17 54	− 24 3	6 42	11 14	3 46

JUPITER.

Dec. 1.	12 24	− 1 18	1 46 A.M.	7 42 A.M.	1 38 P.M.
11.	12 29	− 1 48	1 14	7 8	1 2
21.	12 33	− 2 13	12 40	6 33	12 26
31.	12 37	− 2 31	12 6	5 57	11 48 A.M.

SATURN.

Dec. 1.	16 10	− 19 17	6 35 A.M.	11 27 A.M.	4 19 P.M.
11.	16 14	− 19 30	6 2	10 53	3 44
21.	16 19	− 19 42	5 28	10 18	3 8
31.	16 24	− 19 52	4 54	9 43	2 32

URANUS.

Dec. 1.	15 51	− 19 59	6 20 A.M.	11 9 A.M.	3 58 P.M.
11.	15 54	− 20 6	5 43	10 32	3 21
21.	15 56	− 20 13	5 7	9 55	2 43
31.	15 58	− 20 20	4 30	9 18	2 6

Neptune.

1897.	R. A. H. M.	Declination. °	Rises. H. M.	Transits. H. M.	Sets. H. M.
Dec. 1.	5 23	+21 47	5 24 P.M.	12 42 A.M.	8 0 A.M.
11.	5 22	+21 46	4 44	12 2	7 20
21.	5 21	+21 45	3 59	11 17 P.M.	6 35
31.	5 20	+21 44	3 19	10 37	5 55

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off left-hand limb as seen in an inverting telescope.)

		H. M.			H. M.
III, R,	Dec. 3.	1 20 A. M.	II, D,	Dec. 16.	3 49 A. M.
I, D,	4.	3 13 A. M.	III, D,	17.	6 22 A. M.
II, D,	9.	1 14 A. M.	I, D,	20.	1 27 A. M.
III, D,	10.	2 24 A. M.	II, D,	23.	6 24 A. M.
III, R,	10.	5 17 A. M.	IV, D,	24.	6 49 A. M.
I, D,	12.	11 34 P. M.	I, D,	27.	3 20 A. M.

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Dec. 2.	6 45 P. M.	Dec. 19.	11 39 P. M.
5.	3 34 P. M.	22.	8 28 P. M.
8.	12 23 P. M.	25.	5 16 P. M.
11.	9 12 A. M.	28.	2 5 P. M.
14.	6 1 A. M.	31.	10 54 A. M.
17.	2 50 A. M.		

THE BRUCE PHOTOMETERS OF THE LICK OBSERVATORY.

By R. G. Aitken.

[Abstract.]

A paper with the above title was prepared for the September meeting of the Society, and the following abstract is now printed to put on permanent record some data concerning the instruments.

Photometer II. in principle is identical with Photometer H. described in the H. C. O. *Annals*, Vol. XI., p. 1. It consists of a double image prism, which can be moved along the axis of the telescope to any desired distance from the focus, and a Nicol prism in front of the eye-piece, which can be turned by an amount which is measured with a graduated-circle and index.

In practice, the double image prism is moved toward or away from the focus, and the whole instrument turned on its axis, until the ordinary image of one of the stars to be compared is brought as close as is desired to the extraordinary image of the other star — the two remaining images either being cut off by the eye-

stop, or being symmetrically placed in the field of view, with respect to the two images that are to be compared. The NICOL is then turned until the two images are of equal brightness, and its position is read on the graduated circle. Four such positions are found — one on each side of the two points of disappearance of the brighter image. Turning the whole photometer through 180°, the images at first neglected are brought together and a similar comparison is made. From these readings the angular distance of the point of equality of the images of the two stars (v) from the point of disappearance of the brighter star (v_0) is determined; and the difference in magnitude (M), (using POGSON's photometric scale) follows from the equation

$$M = 5 \log \tan (v - v_0).$$

The Harvard College observers have found that "this instrument leaves little to be desired in the measurement of close double stars. Nearly all sources of systematic error are eliminated when it is properly used, and the relative brightness of two adjacent stars may be determined with great accuracy." In fact, they have found that "the results on different nights will give average deviations considerably less than a tenth of a magnitude."

A careful test of the BRUCE Photometer II., attached to the thirty-six-inch telescope, has proved that it will give results in every way comparable with those obtained with the Harvard instrument.

This photometer, however, when attached to the thirty-six-inch cannot be used to compare stars more than two minutes of arc apart.

The BRUCE Photometer I., which is a duplicate of the "New Form of Stellar Photometer," described by Professor E. C. PICKERING in the *Astrophysical Journal* for August, 1895, is based upon the same photometric principles as number II., and the method of observing and of reducing the observations is the same for both instruments. The only difference is, that only one image of each star is seen in the field of view at one time, the other two images being cut off by the eye-stop.

But in Photometer I. the double image prism, which has an angle of separation of about four inches, is placed at the focus, and two images of the object glass are formed by two achromatic prisms, which can be slid by a chain and sprocket-wheel to a distance of about forty inches from the focus. The position of these prisms is indicated by a divided wheel, which is turned by

a screw cut on the axis of the sprocket-wheel. One turn of the screw moves the prisms about three inches. The achromatic prisms are about two and one-quarter inches (6 cm.) on a side and their combined deviation is $4^{\circ}\ 23'\ 35''$, somewhat greater than that of the double image prism when they are brought near to it, but less when they are moved to their extreme position.

The simplicity of construction of this instrument insures the stability of its adjustments. Practically, it is only necessary to see that the line joining the centres of the two images is perpendicular to the edges of the achromatic prisms. If this is not the case, the adjustment is easily made by turning the tube holding the double image prism.

When the photometer is attached to the thirty-six-inch telescope and the achromatic prisms are brought as near as possible to the focus, stars about two and one-half minutes of arc apart may be compared. This is the minimum limit. The practical maximum limit is reached when the prisms are moved thirty-two inches from the focus, for at this point the diameter of the cone of rays from the object-glass equals the length of the side of the achromatic prism. In this position of the prisms, stars about twelve minutes of arc apart may be compared.

The loss of light by the process of polarization and by reflection and absorption of the various prisms used, reduces the brightness of the stars by about one and one-half magnitudes. It is, therefore, possible to measure with great accuracy the brightness of any star one and one-half magnitudes brighter than the limit of visibility of the telescope.

MT. HAMILTON, September 6, 1897.

CATALOGUE NO. II, OF NEBULÆ DISCOVERED AT THE LOWE OBSERVATORY, ECHO MOUNTAIN, CALIFORNIA.

By LEWIS SWIFT.

The following list of twenty-five nebulæ follows No. I of fifty, discovered at this observatory and published in the *Astronomical Journal* of November 13, 1896, and also in the *Publications* of the Astronomical Society of the Pacific. Since my return to this observatory in April last, after an absence of several months, I have devoted my time to searching for comets, as well as for

nebulæ, for which this anomalous climate is so well adapted. The following facts will illustrate its truth. The number of clear nights in May, 1897, were twenty-five, and rain-fall 0.87 of an inch. On June 28th, rain-fall 0.10; in July, precipitation 0.15. I have never seen a month, except the last, when every night was clear, but in June, 1896, every one was clear with a single exception, and that was foggy. One peculiarity about this climate is, that there are more cloudless nights than days, which is the reverse of conditions at the Warner Observatory at Rochester, New York.

No.	Date of Discovery.	R. A.	Dec. for 1900.	Description.
		h m s	° ′ ″	
1	Mar. 23,'95	8 5 38	+ 5 22 47	eeeF. vS. lE. v close f. 12ᵐ *. D * nf. points nearly to it. eedif.
2	May 4,	11 47 23	— 3 10 12	vF. pS. R. B * f 55ˢ. np of 2.
3	Mar. 23,'95	11 48 33	— 3 25 15	eF. pS. R. 2 B st in field one n the other np.
4	Mar. 23,'95	11 48 48	— 4 34 15	eeeF. vS. eE. a ray. in vacancy. 4 F st in line s. 1 B & 3 F st n.
5	May 23,	11 49 23	— 2 10 0	vF. vS. R. vF * near nf.
6	May 23,	12 43 2	+ 54 59 45	eeF. S. CE. in field with N. G. C. 4732.
7	May 23,	13 4 27	+ 53 22 48	eF. pL. R.
8	May 22,	13 18 33	+ 6 45 16	eeeF. pS. CE. in vacancy. v dif.
9	June 25,	13 47 20	+ 14 46 55	eeeF. pL. R. eeedif. 3d of 4.
10	Apr. 30,	13 47 38	— 0 38 0	vL. pF. CE. n & s. in field with 5334. A F st close to each end of major axis. See note.
11	June 2,	14 46 16	+ 27 59 17	eeF. S. lE. pB * p. eeedif. another near suspected.
12	June 2,	14 49 37	+ 16 47 5	vF. pS. R. only 1 * near 10ᵐ nf.
13	June 21,	15 14 59	+ 2 8 52	vF. vE. pS. B * in field n partly obscures it.
14	June 3,	15 19 52	+ 13 50 10	eF. pS. vF * close np.
15	June 21,	15 30 0	+ 5 2 0	eF. pS. R. near the 1st of 6 or 8 st in a curved line.
16	July 22,	16 18 45	+ 12 59 16	eeeF. S. lE. F * near f. 2 B st in field s nearly point to it. eeedif.
17	July 6,	19 22 0	— 36 24 05	B. eS. lE. stellar. looks like close D * both nebulous. Note.
18	July 6,	19 49 10	— 37 37 13	eeeF. pS. 3 st s like belt of *Orion* point to it. eeedif.
19	July 6,	19 53 17	— 38 53 33	eeeF. S. lE. precedes the below 37ˢ eedif. p of 2.
20	July 6,	19 53 55	— 38 53 33	eeF. pS. R. 8ᵐ * f 20ˢ f of 2.
21	July 8,	19 59 0	— 48 42 25	eeeF. pS. R. F * near n. eedif. p. of 2.
22	July 22,	20 2 16	— 45 55 42	vF. pS. R.
23	June 9,	20 38 39	— 30 16 30	eF. pS. vE. eeF * and a vF * near sf. point to it. s p. of 2.
24	June 9,	20 38 45	— 30 6 30	eeF. pS. vE. 8ᵐ * 31′n. v dif. nf of 2.
25	July 7,	22 35 0	— 38 33 48	vF. pS. R.

NOTES.

No. 10. This is a remarkable object. I have never seen one just like it. It resembles an elliptical planetary nebula. The light is evenly diffused, and the limb as sharp as a planet. Strange, Sir WILLIAM HERSCHEL missed it, being so near his III 665. Munich 9619 is nf 121ˢ.

No. 17. This also is a singular object. I have never seen but one resembling it, and that was on the same night, which I think is N. G. C. 6861. It resembles a close, bright, double star, each component having a small, bright, round, star-like, nebulous disc. A power of 200 failed to divide it.

The places are for 1900.0, and the year of discovery, except when otherwise noted, is for 1897.

N. G. C. 6550 must be struck out, as it is identical with H. III 555.

ECLIPSE OF THE SUN, JULY 29, 1897.

BY DAVID E. HADDEN.

The partial eclipse of the Sun on July 29th ult. was observed in Alta, Iowa, under favorable conditions, the sky being cloudless. First contact occurred at $7^h\ 33^m\ 02^s$; the Sun's disc was a little unsteady, and this time is probably a few seconds late. Last contact was noted at $9^h\ 35^m\ 47^s$ and is quite accurate, the definition being fine.

The limb of the advancing Moon bisected the larger sun-spot nearest the west limb at $7^h\ 47^m\ 20^s$, and its reappearance was observed at $8^h\ 20^m\ 55^s$. An interesting phenomenon was the apparent blackening of the umbra of the sun-spot, as the edge of the Moon reached it (the umbra before appearing a shade lighter than the Moon). I also noticed a peculiar lengthening of the umbra toward the Moon's limb as it reached its edge—a "black drop" appearance on a very small scale. I hardly think this was owing to the inequalities of the Moon's edge, as the same appearance was repeated during the spot's reappearance.

The sunlight was quite decidedly changed about mid-eclipse, and the temperature of the air in the shade fell four degrees, as recorded by a registering minimum thermometer. Time used i

Central Standard. Telescope used was a four-inch BRASHEAR equatorial, with Herschelian eye-piece, power 78.

ALTA, Iowa $\left\{\begin{array}{l}\text{Lat. } 42^{\circ}\ 40'\ \text{N.}\\ \text{Long. } 6^{h}\ 21^{m}\ \text{W.}\end{array}\right\}$ Approx.

NOTES ON THE TOTAL ECLIPSE OF THE SUN, JANUARY 21-22, 1898, IN INDIA.

By COLONEL A. BURTON-BROWN, R. A., F. R. A. S.
[Member of the Astronomical Society of the Pacific.]

The central line of totality on the west coast of India passes between Ratnagiri and Rajapur, the latitude of which place is 16° 40′ N., and longitude 73° 35′ E. of Greenwich. Totality commences 22d—$0^h\ 47^m\ 42^s$; has a duration of nearly $2^m\ 2^s$, and the Sun's altitude is 53°, about. The line of shadow strikes across India, cutting the river Ganges a few miles south of Balia and passing on to Jubang in Nepaul, where the duration of totality would be reduced by about 23^s and Sun's altitude by about one-third. There are many circumstances which will influence observers in selecting stations beyond that of the Sun's altitude and length of totality. The most important one will probably be the weather conditions between $0^h\ 30^m$ and $2^h\ 15^m$. Now, if India were a great plain, we might consider that in the third week in January that the conditions of weather will be equally favorable from the west coast to the Ganges, but as the country is a series of undulations, including some hills, local circumstances must be taken into account, and from my own observations and those of others, I am inclined to consider the height of the station which is from 500 to 1500 feet above the sea would be the most satisfactory if not in close proximity to higher ground, and if not within twenty miles either of the seacoast or the Ganges river. Places from 73° 30′ to 75° 45′ east longitude I find are slightly freer from cloud than places east and west of that longitude. Although the daily mean cloud in other places may not be greater, it is often more variable. I am inclined to advise, from atmospheric conditions as well as the position of the Sun and length of totality, that a fairly elevated position on or near the central line between those limits be taken up. No doubt stations north of Rajapur and Nagpur will be selected by some observers, but while the climatic conditions

should be good there, they will probably not come up to a carefully selected spot near Indapur, Aundh, or Parainda, none of which are difficult to get to with the requisite instruments. I would here take the opportunity of saying, if a fairly large party is formed, they should be divided *as much as possible.* This I strongly urged for the British-Norwegian expedition in 1896, but instead of selecting places near Bodo on the west coast and places on the Tana Fjord and Russian frontier, as well as Vardoe and Vadsoe, they all huddled together at the latter two most accessible places, where, unfortunately meeting with unfavorable atmospheric conditions, no good results were obtained. It must not be forgotten that two or three exceptional circumstances are now occurring in India — famine and plague — and more recently, earthquakes, so that it may be impossible much before the close of the year to give an exact locality suitable for a scientific expedition. We all hope that in the cooler season these unfortunate conditions will be materially improved and that there may be no obstacle to progress in any part of the country. An elevated post near Indapur would give about $1^m\ 58^s$ totality at Sun's altitude of about fifty degrees.

THE CAUSE OF GRAVITATION.*

By V. Wellman.

According to Newton's law of gravitation, the attractive force of matter is proportional to the mass and inversely proportional to the square of the distance. The rigorous validity of this law has, in recent times, been doubted; but its extraordinary approximation to the truth is unquestionable. Consequently, without going into the question as to whether the law is rigorously valid, I will endeavor to verify it.

The propagation of light through interstellar space shows that this space cannot be absolutely vacant. It is filled with material, the condition of which we assume to be like that of a gas of extraordinarily rare density. The barometer-formula gives, for the density of air at an altitude, $h = \infty$, which, therefore, corresponds approximately to the density of the interstellar medium,

$$D_{\infty} = D_0\, 10^{-346},$$

* Translated from *Astronomische Nachrichten* by E. F. Coddington.

where D_0 designates the density of air at sea level. Evidently this formulæ is not exact, since MARIOTT'S law, on which it is based, holds good only for a finite pressure and therefore for a finite altitude. Nevertheless, this value can be regarded as an approximate measure for the density of the interstellar medium. We can also assume that the matter of bodies is composed of a very large number of very minute particles, whose dimensions are exceedingly small compared with the space between them. Suppose we consider a single particle of the Sun and one of a planet. The particles of the interstellar medium move, according to the kinetic theory of gases, with an enormous velocity among each other. If we imagine a body particle, *a*, it will be struck on all sides by particles of the medium; therefore will receive an equal pressure on all sides and will remain at rest. If there exists a second particle, *b*, *a* will not be struck in the direction *ba*, and likewise *b* will not be struck in the direction *ab*. Therefore, the impulses acting on *a* in the direction *ab* and those acting on *b* in the direction *ba*, will tend to push the two particles together; that is, there will seem to be an attractive force between them. The question is, whether this force will act according to NEWTON'S law.

First of all it is clear that a body consisting of *n* particles will receive *n* times the number of impulses, and, therefore, the moving force will be proportional to the mass, provided the single particles are far enough apart not to cover each other from impulses, and that each particle is struck just as often as it would be if it existed alone; or, in other words, provided the interstellar medium can go through the celestial bodies without apparent resistance. Evidently it can and must happen that in a certain element of time some body atoms will cover others, but in the same or equal elements of time other body atoms will receive many impulses. Therefore, according to the theory of probabilities, since the number of particles is assumed to be infinitely large, there will be a constant value for the number of impulses which lies within the limits of our perception, and which is proportional to the number of body atoms or to the mass. The phenomenon of the diffusion of gases seems to give additional evidence that we can assume such a free passage of the interstellar medium.

According to the investigations of GRAHAM especially, the

diffusion volume (V) of a gas is inversely proportional to the density of the gas; that is;

$$V = c\sqrt{1/\delta}.$$

In fact, this law is easily explained from molecular structure. The less dense the particles of a gas are, the more of the same will pass through resisting bodies without striking them. That is, the number n of gas particles going through each row of body particles, is inversely proportional to the density δ of the gas. But if the number of particles passing a row be increased v times, the number passing a cross-section and also the volume will be increased v^2 times, and the ratio of the volumes will be inversely as the square root of the densities.

According to this law, it is evident that the ability of the celestial bodies to allow such a free passage of the interstellar medium of the above-mentioned minimum density must be such that the above-made assumption will appear correct. Of course it will not be maintained here that the passage of the world particles (as we will name those of the interstellar medium) occurs accurately according to GRAHAM'S law; rather it will only be shown that the assumption of this perviousness of the celestial bodies for the world particles in the assumed measure contains no inconsistency or improbability.

We come then to the consideration of the question, whether the power produced by the interstellar medium must act inversely proportional to the square root of the distance. For this purpose we make the assumption that the density of this medium is constant within an attraction system (solar system), if not in the whole universe. This assumption is certainly allowable, since there is no evidence for the opposite assumption of unequal densities; and if there should be inequalities of densities, they would become equalized by expansion in finite distances and in finite length of time. Moreover, it is not absolutely excluded that in other attraction systems, at an infinite distance away, there cannot exist temporarily other densities.

We see that, of the world particles, only those have a dislocating effect upon the body particles which move in a line connecting the two particles; or that the planets are pushed towards the Sun only by those world particles which move in direction radial to the Sun. The number of these motions is independent of the distance from the Sun; therefore, an equal number

world particles will rebound radially against the surfaces of spheres which surround the Sun concentrically. Therefore, the number of impulses received by a surface unit is inversely proportional to the square of the distance, as NEWTON'S law requires.

I will illustrate this point in another way. The pressure of a gas upon the side *q* of the inclosing vessel is,

$$p = c\ m\ u^2\ q\ \frac{n}{l},$$

where *m* is the mass of a gas particle, *u* its velocity, *n* the number of particles, and *l* the length of the enclosing vessel to the opposite side *q*. For $\frac{n}{l}$ we can use the density of the gas δ, whereby we become independent of the assumption of finite enclosed space. Therefore, the pressure of the interstellar medium upon the surface units of two spheres described about the Sun with radii r and r′ is,

$$p = \frac{c\ m\ u^2\ q\ \delta}{r^2\ \pi} \quad \text{and} \quad p' = \frac{c\ m\ u^2\ q\ \delta'}{r'^2\ \pi}$$

According to NEWTON'S law, the following relation should hold: $\frac{p}{r^2} = \frac{p'}{r'^2}$, and, therefore, δ must equal δ'. That is, NEWTON'S law is satisfied if the density of the interstellar medium is constant within the attraction sphere.

It is also easily seen by a simple geometrical representation, without applying mathematical formulæ, that the pressure directed radially toward a center must be inversely proportional to the square of the radius. Within other attraction-spheres in which other densities of the interstellar medium reign, NEWTON'S law of gravitation would still be valid, but the gravitation constant for the unit of mass would have different values. Possibly the remarkable mass and distance relations reigning in some of the systems, such as *Algol*, are due to these conditions. At places of transition, where the density of the medium is variable, a stable system is as a rule impossible.

Since the conceptions given in the above lines will probably meet many objections, I may be permitted to discuss some of the expected ones. To the assumed rare density of the interstellar medium, comes the objection that the number of single impulses of the world particles in the unit of time is far less than that of a particle of gas (earthly), whereby its effect must be correspondingly diminished. But this decrease of effect would

be more than overbalanced by the enormous velocity which we must attribute to the world particles, wholly disregarding the above-made assumptions, except those concerning light velocity. The velocity of the world particles is assumed to be of the same order of magnitude as the velocity of light.

If such a velocity is assumed, the number of particles passing a plane in the unit of time will be increased in the same measure, while the kinetic energy will be increased according to the square of the velocity. To be sure, masses moved with such a velocity appear very improbable, but the assumed wave velocities in the theory of light are no more plausible, and besides an upper limit to cosmical relations can scarcely be drawn. Indeed, the assumed value is not so striking if, instead of the velocity of the world particles, the kinetic energy be introduced, which is infinitely small compared to that of a planet, in spite of their very much greater velocity.

Furthermore, the attraction of the formulæ holding good for the pressure of a gas appears to be unadmissible, since with gases the rectilinear courses traversed by the gas particles are infinitely small compared with those which we have assumed. It is also easily seen that the above-introduced formula for p is nothing other than the expression for the kinetic energy and, therefore, in general, is valid.

NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

)BSERVATION OF THE PARTIAL SOLAR ECLIPSE, JULY 29, 1897.

At Professor HOLDEN'S request, I observed the times of con- ıct for this eclipse, using the twelve-inch telescope cut down to ɔur inches aperture, and a HERSCHEL prism with eye-piece of 50 diameters. The Moon's disc was first seen certainly at $^{h}\ 25^{m}\ 8^{s}$ A.M., P. S. T. Geometrical contact occurred one or wo seconds earlier. The observed time of last contact was $^{h}\ 9^{m}\ 14^{s}$ A.M. These times are seven seconds later and seven econds earlier, respectively, than the predicted times of contact ɔr the Lick Observatory computed by Mr. PERRINE (see *Pub- ıcations* A. S. P., No. 55).

The Moon's disc touched the umbra of a well-developed un-spot on the south-preceding quadrant of the Sun's disc at $^{h}\ 38^{m}\ 12^{s}$, and the umbra had entirely disappeared at $5^{h}\ 39^{m}\ 29^{s}$.

At the time of greatest obscuration about one-third of the ›un's disc was covered. R. G. AITKEN.

MT. HAMILTON, July 29, 1897.

UNUSUAL LUNAR HALO, AUGUST 5, 1897.

NAPA, Cal., August 5, 1897.

* * * * On August 5th at 4:45 P.M. * * * a ircle (appeared) about the Moon, or rather around the circular ıalf. This was distant one-tenth the diameter of the Moon and . bright thread-like line. (It was) at times very distinct, but ıgain undiscernable. * * * *

(Signed) KATE AMES,
School Superintendent.

* Lick Astronomical Department of the University of California.

THE WORK OF THE LICK OBSERVATORY, 1888–1897.*

"In your letter of June 26th, you ask for some account of the work in progress here for *Popular Astronomy*, which I am very glad to give. A report of the sort is annually made to the Regents of the University of California, and from the forthcoming report the following summary is made. It must be remembered that the work of this year is in continuation of previous work, and often in pursuance of plans laid down in 1874—twenty-three years ago. While the resources of the Lick Observatory are large in comparison with those of many college observatories, they are very small in relation to those of the great establishments of Greenwich, Paris, Pulkova, Washington, and Harvard College. For instance, the whole available income of the Lick Observatory for the coming fiscal year (exclusive of salaries) is $5145. This sum must keep all the buildings painted and in repair; keep all our reservoirs and some five miles of underground pipes in order; provide for all painting, plumbing, brick-laying, pipe-fitting, carpenter work, machine work, etc., etc., in the observatory and in the houses of astronomers and workmen; buy all supplies, such as lumber, hay, iron, brick, etc.; pay for all instrument making not done in the observatory; pay all freight, express and telegraph bills; maintain a telephone line seventeen miles long in good order; pay for fuel; purchase books for the library; provide any needed apparatus for all the instruments; and, this year, buy much of the material needed for an eclipse expedition to India. It is no small task to make the small income cover the requirements. Every want that is felt in a large city is felt here. The circumstances at Mount Hamilton are as different as possible from those at eastern observatories. There each person must provide for his own personal comfort; here the comfort of each one must be secured by the expenditure of the annual appropriation. If it is insufficient, every person suffers in some degree.

The astronomical efficiency of the Lick Observatory cannot be properly estimated without taking such material and social considerations into account. Under the circumstances, I do not think it is too much to claim that its efficiency during the nine years of its life has been satisfactory. This has only been attained by good will and earnest effort on the part of all con-

*Reprinted from *Popular Astronomy* of August, 1897.

cerned — regents, astronomers, mechanics, workmen. The summary of work for which you asked, is given below.

Double Stars have been measured here in past years in great numbers by Professor BURNHAM, and at the present time Professors SCHAEBERLE, HUSSEY and AITKEN are engaged in such work for parts of their time.

The Satellites of *Mars*, *Jupiter*, *Uranus* and *Neptune* have been regularly observed here for the past nine years by Messrs. SCHAEBERLE, BARNARD, CAMPBELL and HUSSEY. A fifth satellite of *Jupiter* was discovered by Professor BARNARD in 1892.

The Planets, especially *Mars*, *Jupiter*, *Saturn* (and also *Venus* and *Uranus*), have been systematically observed for their physical features at every opposition by Messrs. HOLDEN, SCHAEBERLE, KEELER, BARNARD and HUSSEY. For several oppositions of *Mars*, the planet has been followed by Messrs. HOLDEN, SCHAEBERLE and CAMPBELL during every available hour.

Comets have been discovered here in great numbers. Ten comets (seven unexpected) were discovered by Professor BARNARD from 1888 to 1892; five (four unexpected) by Mr. PERRINE from 1895 to date. The long series of observations of these and other comets by Messrs. BARNARD, CAMPBELL, HUSSEY, PERRINE and AITKEN, are a contribution to science even more important than the discoveries themselves.

Comet Orbits have been computed here by Messrs. SCHAEBERLE, CAMPBELL, HUSSEY, PERRINE and AITKEN; and all comets discovered at the observatory have had their first orbits calculated by officers of the University. In this work, Professor LEUSCHNER, of Berkeley, a former student here, and his assistant, Mr. F. H. SEARS, have rendered assistance which is much appreciated.

Meteors have been observed and photographed here (and elsewhere) by all the astronomers, and their orbits calculated by Messrs. HOLDEN and SCHAEBERLE.

Double-Star Orbits have also been computed by Professor SCHAEBERLE.

The Zodiacal Light was regularly observed (visually) by Professor BARNARD.

The Aurora has been regularly observed (spectroscopically) by Professor CAMPBELL.

Typical, or Remarkable Cloud-forms are regularly photographed by Mr. PAULI, janitor of the observatory.

Nebulæ have been observed (visually, photographically and spectroscopically) by Messrs. HOLDEN, BURNHAM, SCHAEBERLE, BARNARD and CAMPBELL.

Star Maps have been made and published by Mr. TUCKER.

Photometry (photographic and visual):—of Eclipses and Stars—has been attended to by Messrs. HOLDEN, SCHAEBERLE, CAMPBELL and LEUSCHNER.

Solar Eclipses:—Those of January and December, 1889, April, 1893, August, 1896, have been observed by Messrs. BURNHAM, SCHAEBERLE, KEELER, BARNARD, HILL, LEUSCHNER and CAMPBELL—and the latter will observe the eclipse of January, 1898, in India.

Lunar Eclipses.—All lunar eclipses visible here have been observed.

Occultations.—A series of occultations has been observed here by Professor LEUSCHNER.

Transits of *Mercury*.—Three transits of *Mercury* have been observed (either visually or photographically).

Transits of *Venus*.—That of 1882 was successfully photographed here by Professor TODD.

Catalogues of Stars.—Two such are in progress of preparation.

1st. A Catalogue of Double Stars and Coast Survey Stars from observations by Professor SCHAEBERLE has been (partly) reduced, on lines laid down by myself, by Messrs. SCHAEBERLE, CAMPBELL, LEUSCHNER, AITKEN and Professor BIGELOW, and Mrs. UPDEGRAFF. Professor AITKEN has spent more than a year on this work.

2d. A Catalogue of 38,000 Stars from Washington observations is well towards completion. The reductions have been made chiefly by Messrs. HOLDEN and AITKEN. The original observations as printed were full of errors. The final places will be considerably more precise in declination and somewhat less precise in right ascension than the southern zones of Argelander.

Solar Photography.—Some 1800 negatives of the Sun (taken with the photoheliograph) have been secured by Mr. PERRINE, and since April, 1896, some 450 more by Mr. COLTON. Excellent experimental solar photographs on a large scale have been made with the thirty-six-inch telescope, and it is hoped to go very much further with this work during the summer of 1897.

Lunar Photography.—A very full series of focal negatives has been made with the thirty-six-inch telescope, chiefly by Messrs.

HOLDEN and COLTON. An atlas on the scale of X-feet to the Moon's diameter has been prepared from these by Professor WEINEK at Prague. Enlargements in the telescope have been made by Messrs. HOLDEN, COLTON and PERRINE, and five plates of a Moon atlas on the scale of III-feet to the Moon's diameter have already been distributed. Twelve more plates are now in the hands of the engraver and will soon be issued; and about twenty more are ready to be published when the funds are available. The atlas will be complete with about sixty plates. All the work in the dark room is done by Mr. COLTON.

Photographs of the Milky Way.—A great number of such pictures has been obtained by Professor BARNARD, who is preparing them for publication.

Photographs of Planets (especially of *Jupiter*) have been regularly made by Messrs. HOLDEN, SCHAEBERLE and COLTON.

Photographs of Comets have been secured by Messrs. BARNARD, HUSSEY and COLTON.

Visual Photometry.—Two fine photometers of Professor PICKERING'S design have lately been given to us by Miss BRUCE. They will be used by Professor AITKEN, chiefly on double stars at present.

Spectroscopic Observations of nebulæ, new stars, comets, stars and planets, have been made by Messrs. KEELER and CAMPBELL. The chief problem of the great telescope is to determine the motion of the solar system by spectroscopic observations. It was first attacked here in 1888, and since that time it has been considered as our most important work. The results now attained by Professor CAMPBELL are of unexampled precision, and some of them will be published shortly. Many unexpected delays have occurred in this research, which has been under the charge of Messrs. KEELER, CREW and CAMPBELL.

Time-signals are sent out daily. Mr. TUCKER is in charge of our clocks.

Meridian-Circle Observations.—Mr. TUCKER has completed a fine series of observations of all stars contained in any of the great Ephemerides and *not* contained in the *Berliner Jahrbuch*. This work is all ready to print. He has also determined the places of a long list of stars used by Professor DOOLITTLE to determine the latitude of Lehigh University. The division errors of the one degree spaces of both circles of the instrument

have been determined by Mr. TUCKER, with the assistance of Mr. AITKEN.

Meteorological Observations (tri-daily) have been regularly made. They are now in charge of Professor AITKEN. A summary of all meteorological observations made here from 1888 to 1897 is in course of preparation by Mr. PERRINE.

Earthquake Observations are obtained on our two seismographs, which are in charge of Mr. PERRINE. A complete list of all recorded earthquakes on the Pacific Coast from 1769 to 1897, has just been prepared by Professor HOLDEN.

Publications of the Observatory.—The observatory has already issued three quarto volumes and five octavos, besides several pamphlets and the Moon-Atlas. The Smithsonian Institution has lately published an octavo prepared here by Professor HOLDEN — "Mountain Observatories"—and will probably print his list of recorded earthquakes, just mentioned. Notices from the Lick Observatory regularly appear in the *Publications* of the Astronomical Society of the Pacific. More than 1200 contributions to astronomical and other journals have been made by the officers of the observatory since 1888.

Trial of the CROSSLEY Reflector.—This fine instrument, which has done such good work in the hands of Mr. COMMON, was presented to the Lick Observatory by Mr. CROSSLEY in 1895. It was completely mounted in June, 1896, and given over to Professor HUSSEY for trial. The work begun in 1896 is now being prosecuted. Photography in the Newtonian and principal foci will be tried by Professor HUSSEY, and Professor CAMPBELL has a programme of spectroscopic observations to be carried on with the BRUCE spectrograph (constructed here) in the principal focus. A powerful driving-clock (the BRUCE clock) has been made here from drawings by Professor HUSSEY. It is essentially a copy, in little, of the WARNER & SWASEY clock of the thirty-six-inch equatorial. Its conical pendulum weighs about fifty-six pounds.

The SCHAEBERLE eighteen-inch Reflector has been used for some years past in experiments in celestial photography by its maker, Professor SCHAEBERLE. Very interesting photographs of *Jupiter* have been obtained.

The CROCKER Photographic Telescopes (a pair of WILLARD portrait lenses) will soon be mounted in a new dome near the CROSSLEY reflector. A twelve-inch mirror (by Professor SCHAE-

BERLE) of very short focus, is to be mounted on the same stand."

EDWARD S. HOLDEN.

LICK OBSERVATORY, July 7, 1897.

INVENTORY, ETC., OF LICK OBSERVATORY BUILDINGS AND EQUIPMENT, JUNE 30, 1897.

Mr. PERRINE, Secretary of the Lick Observatory, has prepared a complete estimate of the *cost* of the buildings, instruments and equipment of the Lick Observatory up to June 30, 1897, inclusive. It is, summarized, as follows:—

Cost of buildings, permanent equipment, etc., paid from the Lick Fund, 1875–1897	$609,981.84
(This leaves an endowment fund of $90,018.16.)	
Ditto, paid from the annual budgets of the Lick Observatory, 1888–1897	11,767.10
Ditto, paid from special appropriations by the Regents of the University, made to provide for specific wants	2,278.00
Ditto, from gifts made by friends of the Lick Observatory	35,131.76
Total, ...	$659,158.70

August 7, 1897.

EDWARD S. HOLDEN.

COST OF THE LIBRARY OF THE LICK OBSERVATORY, 1875–1897.

The total cost of the Library (including buildings, etc.) up to July 1, 1889, was	$5,235.50
Of this sum, the Lick Trustees expended $4837.36 previous to June 1, 1888; and $398.14 was spent by the University of California, mostly for periodicals and binding.	
Between July 1, 1889 and July 1, 1897, the following expenditures have been made:—	
From the annual budgets of the Lick Observatory,	2,023.31
From gifts by Miss BRUCE	22.50
From gifts by Mrs. HEARST	425.13
Total cost of the Library	$7,706.44

The collection contains about 4121 books and 3912 pamphlets, or about 8033 numbers.

E. S. H.

OBSERVATORY MOON ATLAS.

The following nineteen plates have been made by the New York Photogravure and Color Company (No. 241 West Twenty-third street), and will soon be distributed. Besides these, it is proposed to reprint the heliogravure frontispiece to Volume III of the quarto *Publications* of the Lick Observatory as Plate A: 1891, October 12, $7^h\ 30^m\ 54^s.5$; Moon's Age = 10 days, 3 hours (Moon in the focus of the 36-inch refractor). A number of other negatives for the atlas are ready for printing as soon as funds are available.

EDWARD S. HOLDEN.

MT. HAMILTON, September 9, 1897.

OBSERVATORY MOON ATLAS.

DATE.	NEGATIVE TAKEN ON							MOON'S AGE.
				h.	m.	s.	s.	
1	1895,	October	10,	16	49	10	— 17	22 days, 16 hours.
2	1895,	"	9,	16	55	30	— 40	21 " 16 "
3	1895,	"	8,	15	9	10	— 20	20 " 14 "
4	1895,	"	9,	16	53	2	— 12	21 " 16 "
5	1896,	"	18,	10	32	41	— 47	12 " 8 "
6	1897,	April	9,	9	8	21.5	— 28.5	8 " 1 "
7	1895,	October	7,	13	6	20	— 28	19 " 12 "
8	1895,	"	8,	15	6	8	— 18	20 " 14 "
9	1896,	June	17,	9	4	2	— 10	6 " 20 "
10	1895,	October	7,	12	57	18	— 24	19 " 12 "
11	1895,	"	8,	15	3	10	— 20	20 " 14 "
12	1897,	April	9,	8	55	25.5	— 31.5	8 " 1 "
13	1896,	October	18,	10	40	19	— 23	12 " 8 "
14	1896,	July	26,	12	59	25	— 33	16 " 13 "
15	1896,	August	20,	11	57	46.5	— 50.5	12 " 3 "
16	1896,	July	26,	13	8	55	— 63	16 " 14 "
17	1897,	April	13,	9	35	56.5	— 61.5	12 " 1 "
18	1897,	"	13,	9	42	29.5	— 35.5	12 " 1 "
19	1895,	August	30,	9	14	—	——	10 " 16 "

ALBERT MARTH; BORN 1828, DIED 1897.

The death of ALBERT MARTH, in September, 1897, takes away the last astronomer who was a pupil of BESSEL. MARTH was born in Colberg, May 5, 1828, and studied at the Universities of Berlin and Kœnigsberg. His first official position was that of astronomical observer at the University of Durham. He was the assistant of Mr. BISHOP at Regent's Park and of Mr. LASSELL

n his Malta Expedition, and latterly the astronomer of Colonel Cooper's Observatory at Markree. His published writings are in many fields of astronomy, both theoretical and practical, though his *forte* was calculation rather than observation. The asteroid *Amphitrite* was discovered by him, as well as a long list of faint nebulæ at Malta. We owe to him calculations of the orbits of many comets and asteroids. The orbits of satellites he took in his especial charge, and for more than thirty years he provided observers with ephemerides of these bodies, as well as with ephemerides for the physical observation of the planets and the Moon for a great part of this time. These ephemerides, regularly issued on a uniform plan, have been of the greatest service to astronomy. They encouraged the observation of satellites and planets, and compelled a comparison of the results with theory. Marth's writings on Theoretical Astronomy (theory of the motions of satellites, Kepler's problem, orbits of binary stars, etc.), and on Practical Astronomy (Theory of instruments, Division Errors, Flexure, etc.) have been useful. His criticism of the methods of reduction of the Greenwich observations was well founded in several respects; but it naturally made him no friends in official circles. He was a most useful aid to Mr. Lassell, whose great talents lay rather in mechanics than in the making and reduction of astronomical observations. The Malta Expedition was a memorable event, and will remain a lasting credit to England and to Lassell and his assistant, Marth.

Edward S. Holden.

Resignation of Mr. Colton.

On August 18, 1897, Mr. Colton, Assistant Astronomer in the Lick Observatory, tendered his resignation, after a service of a little over five years.

E. S. H.

A New Celestial Atlas.

Atlas der Himmelskunde.—Atlas of Astronomy, based on celestial photographs—with sixty-two plates containing 135 single astronomical objects, and text containing about 500 illustrations—by A. von Schweiger-Lerchenfeld. Published by A. Hartleben, Vienna, in thirty parts (issued twice a month), at one German Mark ($0.25) per part.

On page 145 of the present volume, a notice of Baron von Schweiger-Lerchenfeld's Celestial Atlas was printed under

an erroneous heading. The description given above is the correct one, and it will be seen that the price of the Atlas is about $7.50 only. Some fourteen parts have already been issued, and the rest are nearly ready for publication. E. S. H.

September 16, 1897.

Portraits of Astronomers and Others Belonging to the Lick Observatory.

The following names should be added to the list given on page 95, to-wit:—

Caswell, A.
Edwards, G. C.
Eichbaum, H.
Faye, H.
Gibbes, L. R.
Jarboe, J. R.
Michie-Smith, C.
Mitchell, O. M.
Peirce, C. S.
Porter, J. G.
Rogers, W. B.
Saegmüller, G. M.
Saxton, J. G.
Schumacher, H. C.
Stone, E. J.
Thaw, A. B.

Minutes of a Special Meeting of the Board of Directors of the Astronomical Society of the Pacific, held in the Rooms of the Society, on Saturday, August 14, 1897, at 2:00 P.M.

President ALVORD presided. A quorum was present. The minutes of the last meeting were approved.

The Bruce (Gold) Medal of the Astronomical Society of the Pacific.

Mr. HOLDEN presented to the Board of Directors a communication from Miss CATHERINE WOLFE BRUCE, of New York City, as follows:—

810 FIFTH AVENUE, NEW YORK CITY, MAY 15, 1897.

To the Directors of the Astronomical Society of the Pacific:—

GENTLEMEN:—It is my desire to found and endow a gold medal to be awarded by the Astronomical Society of the Pacific, not oftener than annually, for distinguished services to Astronomy. I desire that the medal shall be international in character, and that persons of any country and of either sex may be eligible to receive it. I have taken the counsel of competent advisers in the preparation of the accompanying statutes for the bestowal of the medal. If your Board of Directors will undertake the administration of the Trust, I shall be glad to turn over to your Treasurer the sum of $2750, which I understand will be sufficient to carry it out. It is my hope, with your co-operation, to establish a foundation which shall be useful to Astronomy now and always.

I am, Gentlemen,

Very respectfully and sincerely yours,

CATHERINE WOLFE BRUCE.

This letter was accompanied by the statutes for the bestowal of the BRUCE Medal of the Astronomical Society of the Pacific, as printed in the *Publications*, No. 57.

After reading the foregoing, it was on motion,

Resolved, That the Board of Directors of the Astronomical Society of the Pacific, in its own behalf, and on behalf of the Society, accepts with gratitude Miss BRUCE's generous gift which, in connection with her many previous benefactions to the Astronomy of America and Europe, will forever connect her name with the history of the Science.

Resolved, That the conditions of the gift as expressed in the Statutes for the bestowal of the BRUCE Medal of the Astronomical Society of the Pacific are hereby accepted by the Directors in their own behalf, and on behalf of the Society.

Resolved, That the gift of Miss BRUCE be divided into two portions, namely: $2500, which constitutes the *Bruce Medal Fund*; and the residue, which is hereby placed at the disposal of a Special Committee,* to consist of Messrs. HOLDEN, ST. JOHN and ZIEL, who are authorized to procure the necessary dies and to strike off one gold medal and nine bronze *replicas*. The gold medal is to serve for the first award; the bronze *replicas* are to be sent by the Secretaries of the Society as follows:—

The first to Miss BRUCE;
One to the Astronomical Society of the Pacific;
One to the Smithsonian Institution;
One to the Harvard College Observatory;
One to the Lick Observatory;
One to the Yerkes Observatory;
One to the Observatory of Paris;
One to the Observatory of Greenwich;
One to the Observatory of Berlin.

*The Committee suggested, consisted of Messrs. ALVORD, HOLDEN and ZIEL. Mr. ALVORD requested that his name be withdrawn and the name of Mr. ST. JOHN be substituted in his stead, which was accordingly done.

The Treasurer is authorized to advance from the General Fund, whatever may be necessary to carry out the foregoing; all advances to be subsequently repaid from the interest on the BRUCE Medal Fund.

Resolved, That the *Bruce Medal Fund* be placed under the immediate care of the Finance Committee, which Committee shall, through the Treasurer, annually print a separate account of this fund.

Resolved, That the By-laws of the Society, the Statutes for the bestowal of the BRUCE Medal, and the Rules relating to the Comet Medal, be printed in an extra number of the *Publications*, in an edition of 1500 copies.

In order to insure the prompt printing of the *Publications*, it was

Resolved, That the Committee on Publication is formally authorized to postpone the printing of any manuscript received later than ten days before the stated dates of issue of the regular numbers (namely: February 1, April 1, June 1, August 1, October 1, December 1) when necessary.

The following members were duly elected:

LIST OF MEMBERS ELECTED AUGUST 14, 1897.*

Miss KATE AMES	Napa, Cal.
Mr. WALTER C. BAKER	1467 Euclid Ave., Cleveland, Ohio.
Mr. CHARLES R. BISHOP	Occidental Hotel, S. F., Cal.
Mr. E. F. CODDINGTON	Lick Observatory, Mt. Hamilton, Cal.
Mr. HENRY EICHBAUM	3 Devonshire Terrace, Ventnor, Isle of Wight, England.
Mr. JAMES MONROE GOEWEY	Page and Laguna Sts., S. F., Cal.
Mr. CHARLES C. KEENEY*	2220 Clay St., S. F., Cal.
Mr. JOHN W. KENDRICK	Gen. Mgr. N. P. R. R., 230 Oak Grove St., Minneapolis, Minn.
FREE PUBLIC LIBRARY	Worcester, Mass.
Mr. JOHN MARTIN	Puruatanga, Martinborough, Wairarapa, Wellington, New Zealand.
Colonel C. McC. REEVE	First Minnesota N. G., Minneapolis, Minn.
Mr. THOS. W. STANFORD*	142 Russell St., Melbourne, Victoria.

Secretary PERRINE reported that sundry articles of bedding, etc. (see *Publications* A. S. P., No. 54, page 49), had been disposed of for the sum of twelve dollars. His report was accepted and filed.

Adjourned.

MEETING OF THE BOARD OF DIRECTORS AND OF THE SOCIETY, SEPTEMBER 4, 1897.

Saturday, September 4th, was the date for a regular meeting of the Directors and of the Society at Mt. Hamilton. As no quorum for the transaction of business (in either body) was present, no meetings were held. The papers presented for reading will be printed in the *Publications* in due course.

* A star signifies Life Membership.

Minutes of a Special Meeting of the Board of Directors of the Astronomical Society of the Pacific; held on Saturday, September 18th, at 1:30 P.M.

President Alvord presided. A quorum was present. The minutes of the last meeting were approved.

The following members were duly elected:

List of Members Elected September 18, 1897.*

Mr. John Bermingham*	330 Market St., S. F., Cal.
Mr. Thomas B. Bishop*	532 Market St., S. F., Cal.
Mr. George Crocker*	Mills Building, New York, N. Y.
Mr. William H. Crocker*	Crocker - Woolworth National Bank, S. F., Cal.
Mr. H. Dutard*	2616 Buchanan St., S. F., Cal.
Mr. Russell J. Wilson*	2027 California St., S. F., Cal.
Library of St. Gertrude's Academy.	Rio Vista, Cal.

Adjourned.

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* A star signifies Life Membership.

OFFICERS OF THE SOCIETY.

Mr. William Alvord	*President*
Mr. Edward S. Holden	*First Vice-President*
Mr. Frederick H. Seares	*Second Vice-President*
Mr. Chauncey M. St. John	*Third Vice-President*
Mr. C. D. Perrine Mr. F. R. Ziel	*Secretaries*
Mr. F. R. Ziel	*Treasurer*

Board of Directors—Messrs. Alvord, Holden, Molera, Morse, Miss O'Halloran, Messrs. Perrine, Pierson, Seares, St. John, von Geldern, Ziel.

Finance Committee—Messrs. William M. Pierson, E. J. Molera, and C. M. St. John.

Committee on Publication—Messrs. Holden, Babcock, Aitken.

Library Committee—Messrs. Hussey and Seares and Miss O'Halloran.

Committee on the Comet-Medal—Messrs. Holden (*ex-officio*), Schaeberle, Campbell.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. Ruthven W. Pike.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—M. Francisco Rodriguez Rey.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars per volume to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

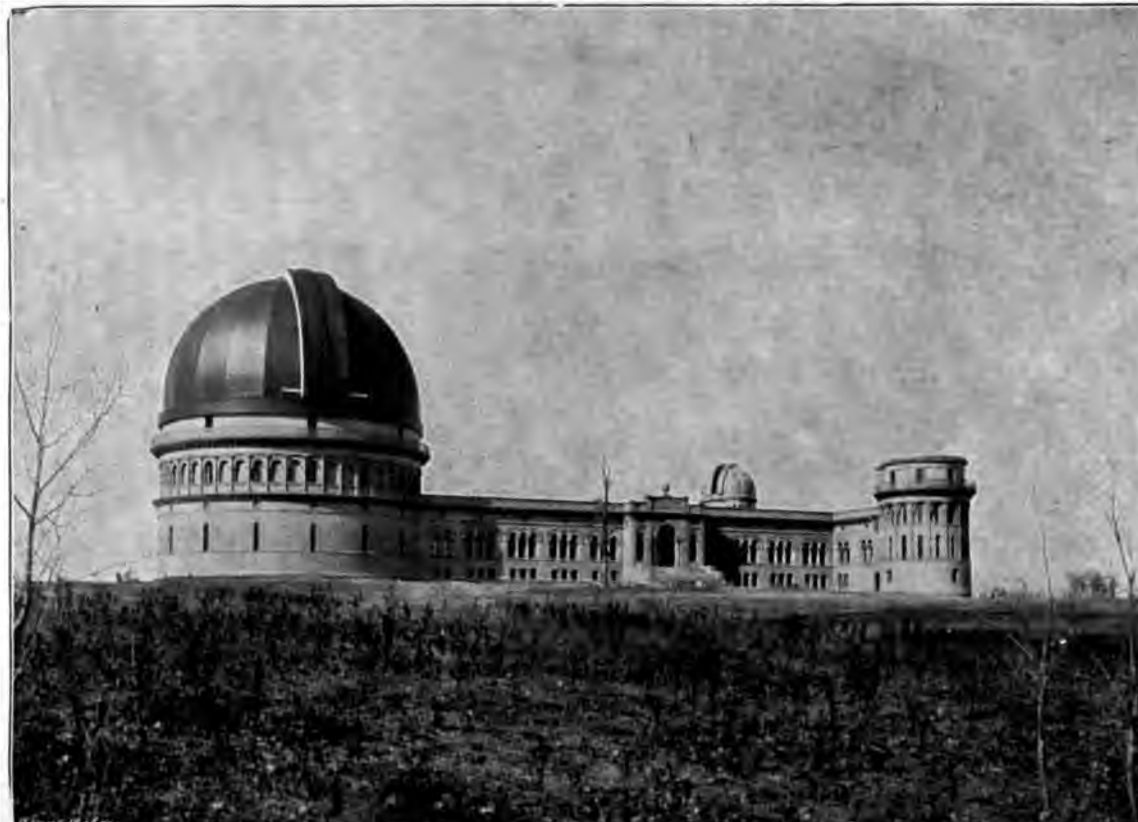
The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)



THE SOUTH FRONT OF THE YERKES OBSERVATORY.

BEFORE THE ERECTION OF THE SOUTHEAST DOME.

PUBLICATIONS

OF THE

Astronomical Society of the Pacific.

VOL. IX. SAN FRANCISCO, CAL., DECEMBER 1, 1897. No. 59.

THE YERKES OBSERVATORY.

By WILLIAM J. HUSSEY.

The Yerkes Observatory has been dedicated, and its active existence as a scientific institution commenced. On the 21st of October, within the great dome, and in the presence of a large assemblage, the donor, Mr. CHARLES T. YERKES, formally presented the observatory and its great telescope to the University of Chicago, and they were formally accepted for that institution by Mr. MARTIN A. RYERSON, the President of the Board of Trustees.

The dedication of this observatory is an important scientific event of the year, inaugurating, as it does, the work of a great institution devoted to the discovery and teaching of scientific truth, and forming an epoch in its history by separating the period of construction, which has extended over the past five years, from the period of its scientific activity, which is just beginning. The dedication was made the occasion of a large gathering of astronomers and scientific men, and a series of conferences on astronomical and astrophysical subjects, with discussions and laboratory demonstrations of new and interesting phenomena, was held at the observatory during the three days preceding the formal exercises. These exercises were held in the great dome of the observatory on October 21st, and were continued in Chicago the following day. The leading address at the observatory was by Professor JAMES E. KEELER, on "The Importance of Astrophysical Research and the Relation of Astrophysics to other Physical Sciences." Other addresses were made at this time, by Mr. YERKES, in presenting the observatory

to the university; by Mr. RYERSON, in behalf of the Board of Trustees in accepting it, and by President HARPER, in behalf of the faculty. In Chicago, Professors MICHELSON and STRATTON gave brilliant demonstrations with new forms of physical apparatus, having possible applications to the solution of certain pending problems of astronomy. In the afternoon, Professor NEWCOMB delivered his address at Kent Theater, on "Aspects of American Astronomy," and that evening, in conclusion, Mr. YERKES provided a banquet for the visiting scientists.

The Kenwood Observatory and the Yerkes Observatory are so related, that an account of the latter would be incomplete without some mention of the former, and in historical order the former comes first.

The Kenwood Astrophysical Observatory had its beginning in a spectroscopic laboratory, which Professor GEORGE E. HALE erected in Chicago in the spring of 1888. In the winter of 1890–91, extensive additions were made to this, converting it into an observatory proper, with an equipment designed especially for the study of solar phenomena by spectroscopic and photographic methods. The observatory was provided with an equatorial telescope of 12.2 inches aperture. The mounting, which was made by Messrs. WARNER & SWASEY, was large and heavy, and was designed to carry a very large spectroscope. The objective and the spectroscope were made by Mr. BRASHEAR. In connection with the observatory a workshop was fitted up, supplied with such machinery and tools as were necessary for the construction, repair, and modification of apparatus.

Professor HALE was not long in obtaining important results with his new equipment. Early in April, 1891, soon after the telescope had been set up, he succeeded in photographing the spectra of the solar chromosphere and prominences for the first time without an eclipse. Within a year or two, he had discovered new lines in the spectra of the prominences, spots, and faculæ; had obtained photographs of the prominences with the H and K lines and an open slit; had matured his invention of the spectroheliograph and had one constructed by Mr. BRASHEAR, and by its use had secured photographs of all the prominences visible around the entire circumference of the Sun at a single exposure, and then by a second exposure, had obtained on the same plate the forms of the regions on the Sun's disk, even in its brightest parts, over which the H and K lines are reversed, and had shown that these

forms are identical with the forms of the faculæ obtained by photographs taken in the ordinary way.

At the time of its opening, in the fall of 1892, the University of Chicago was entirely without facilities for research in astronomy and astrophysics. Through the care of Professor HALE and others, the matter received the immediate attention of President HARPER and the Board of Trustees, and in a very short time they had obtained from Mr. YERKES an expression of his willingness to defray the entire cost of a large telescope.

Some years previously a large telescope was planned for the University of Southern California. Large disks of glass for the objective of this instrument were ordered from MANTOIS, of Paris, and, when they were made, were forwarded to the opticians, Messrs. ALVAN CLARK & SONS, Cambridgeport, Mass. This is as far as the matter went. The order to finish the objective never came. In 1892 these disks still remained in the shops of the opticians, and were then for sale. When Mr. YERKES was informed that these large disks of excellent glass could be obtained immediately, he authorized their purchase for the University of Chicago, and entered into a contract with Messrs. ALVAN CLARK & SONS for finishing an objective from them. He also made a contract with Messrs. WARNER & SWASEY for an equatorial mounting for the telescope that bears his name. It thus came about that, within a few weeks from the time his gift was announced, the orders for the objective and for the mounting had been given. Mr. YERKES then wrote to President HARPER: "I have felt it proper that the telescope should have a home, to be paid for by me; and I have concluded to add to my gift an observatory necessary to contain the instrument."

A site for the new observatory was not selected immediately. Professor HALE was chosen Director, and the equipment of the Kenwood Observatory was presented to the University of Chicago, to become a part of the Yerkes Observatory. It appeared to Professor HALE that the exceptional instrumental advantages of the new observatory should not be wasted by a mere duplication of the work done equally well elsewhere, and that the large telescope should not be employed in the observation of objects within easy reach of smaller instruments. Notwithstanding the number of observatories that had been established in various parts of the world, and the importance of the subject, comparatively little attention was being devoted to the phenomena presented by

the Sun. He accordingly outlined a plan of work, in which the study of solar phenomena in all phases, and on a more extended scale than had been possible with the equipment of the Kenwood Observatory, formed an important part.

The great size of the telescope, its light-grasping power, and long focal length make it especially suitable for the measurement of faint and difficult objects, for the study of planetary markings, and for the spectroscopic observation of the stars. These considerations led to the inclusion in the plan of work of micrometric observation of difficult double stars, nebulæ, planets, satellites, comets, and stellar spectroscopy. Stellar and nebular photography, meridian observations, and various kinds of laboratory work of an astrophysical character were also included in the plan.

Professor HALE next considered the requirements of the various kinds of work intended to be pursued as dependent upon the quality of the seeing, the transparency of the atmosphere, the blackness of the sky, and the steadiness of the instrument used. After a study of the requirements, he wrote as follows concerning the selection of the site: "It is evident that in these various classes of work, the greater part do not require very good seeing; but on account of the importance of the double-star observations, and those of planets, satellites, the structure of the photosphere, etc., it was eminently desirable to choose a site at which the seeing would be the best attainable by night and by day. Some of the other researches demand a dark sky and great transparency of the atmosphere, while for still others the principal requisite is complete protection of the instruments from vibration of any kind. If there had been absolute freedom of choice, a site combining the excellent conditions for night work enjoyed at Mt. Hamilton with the good day seeing existing elsewhere would have been sought far and wide, without regard to geographical boundaries."

From a consideration of the plan of work, and the conditions necessary for the most successful prosecution of certain lines of it, it was at once apparent that Chicago, or any place in its immediate vicinity, would be an unsuitable location for the observatory. When this became generally known, numerous offers of land and other inducements to secure the observatory were made by individuals and by towns in various parts of the country. A practical consideration of no small weight in determining the location of the observatory was, that its value as a depart-

ment of the university should not be materially affected. This required that it be located within a reasonable distance of Chicago, preferably within a hundred miles.

A committee of the Board of Trustees was appointed to select a site. After visiting the most promising places proposed, this committee reported in favor of accepting a tract of land offered by Mr. JOHN JOHNSON, Jr., of Chicago, situated on the northern shore, near the western end of Lake Geneva, in Southern Wisconsin. In speaking of this tract of land in its report, the committee says: "It is conceded by all concerned that no site thus far suggested combines in itself so many requirements, or any of the requirements, to so great a degree. The site is high and beautifully located. The atmosphere is clear, without danger of encroachments of manufactories, railroads, or electric lights." The Board of Trustees adopted the report of the committee, and the observatory has been built on the land given by Mr. JOHNSON. This tract contains 53 acres. The observatory stands in the midst of it. The center of motion of the great telescope is about 240 feet above the level of Lake Geneva, and about 1800 feet from its shore. The elevation of the site above sea level is about 1200 feet. It is 38 miles from Lake Michigan, and about 75 miles from Chicago. The nearest town is Williams Bay, about a mile distant. This is the terminus of a branch of the Chicago and Northwestern Railway. Lake Geneva, seven miles away, is the nearest town having electric lights. The country round about is woodland and cultivated fields, a beautiful region, already a favorite summer-residence place for people of Chicago.

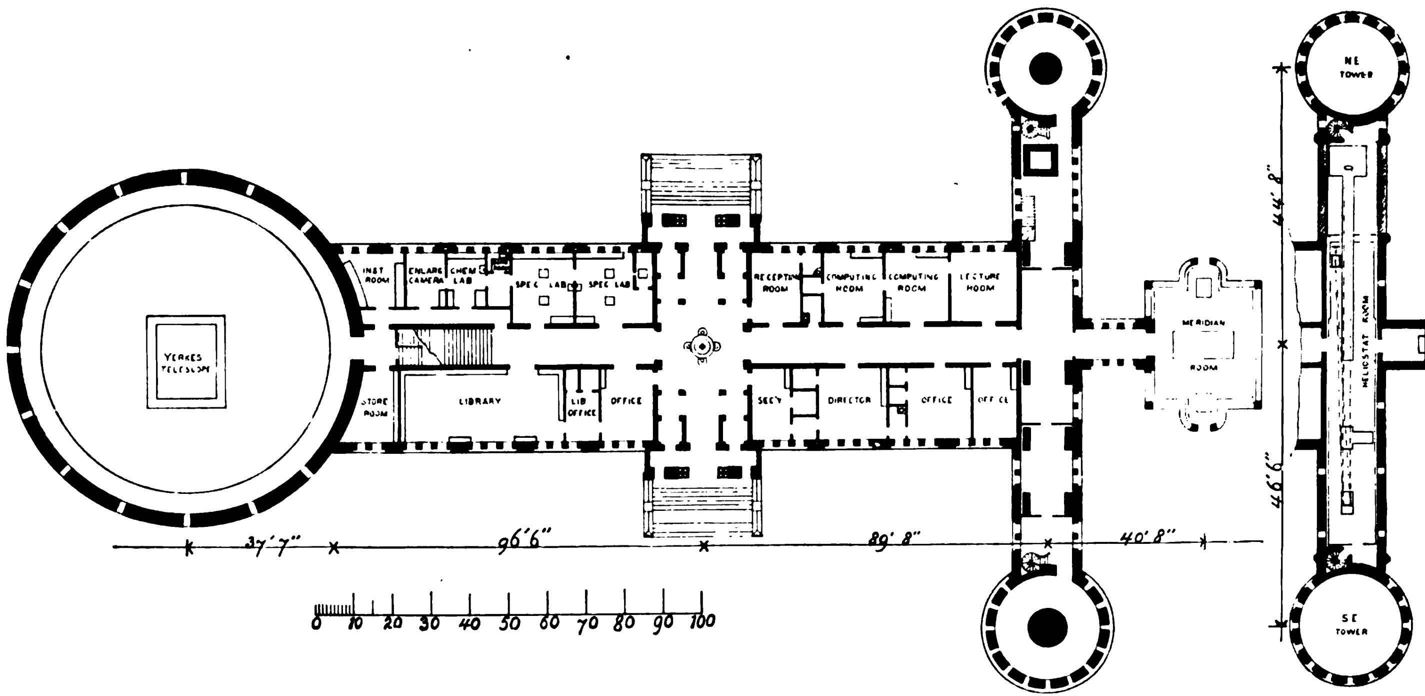
When the lines of work to be pursued by the new observatory had been decided upon, and a site selected which, all requirements considered, promised to be the best, the next problem that confronted Professor HALE was, the plan of an observatory building suited to the scientific requirements and to its environment. To plan such a building was not an easy task. The new observatory was not to be one engaged predominantly with the astronomy of position, nor was it to be merely a spectroscopic laboratory. It was to combine both these lines of work on an extensive scale, and besides to be prepared to meet the needs of such other departments of research as might arise.

The subject was one of such importance that Professor HALE visited and studied the most important observatories and spectroscopic laboratories of the United States and Europe in search of

ideas to enable him to formulate plans embodying the results of experience and meeting the scientific requirements in the most satisfactory manner. The preliminary plans were completed in Berlin in February, 1894, and forwarded to the university architect, Mr. HENRY IVES COBB, of Chicago. During the following year, Mr. COBB worked out the details of the plan with great care, and without sacrificing architectural effect he conserved the scientific requirements. The plans were finally completed in February, 1895, and the work of construction, beginning in April of that year, has since gone on, with some interruptions, until the recent completion of the observatory.

The style of architecture adopted for the main building is Romanesque, with somewhat Saracenic details. The foundation is concrete, and the constructive materials are brown Roman brick with terra-cotta ornaments of the same color. The partitions are of hollow tile, the floors and roof are supported by steel I-beams. The roof is of tile, the floor of the main hall is marble mosaic, and those of the offices and laboratories are maple. The doors and woodwork throughout the building are of antique oak. The form of the building is that of the Latin cross, with the longer axis (326 feet long) lying in an east and west direction, having the tower for the great dome (92 feet in diameter) at the western extremity, and the room for the meridian-circle (28 by 25 feet) at the eastern extremity. For the present, a transit instrument will be used in this room, but it is intended that this shall give place after a time to a large meridian circle. Towers also rise at the ends of the shorter axis of the cross. The northeast tower carries the dome (26 feet in diameter), which was formerly a part of the Kenwood Observatory, and the southeast tower is surmounted by a dome 30 feet in diameter. The 12.2-inch telescope of the Kenwood Observatory is now mounted in the northeast dome. A 24-inch reflecting telescope for stellar spectrographic work is being constructed for use in the southeast dome.

The main entrances to the observatory are on the north and south sides of the building. They are exactly alike, and both lead to the central rotunda. A long hall divides the building centrally lengthwise. The rooms of the main floor have their entrances into this hall or into the rotunda. The rooms on this floor are those designed for offices, computing, reception, and lecture rooms, library, chemical and spectroscopic laboratories, and those for



MAIN FLOOR OF THE YERKES OBSERVATORY.

instruments and storage. The ground floor or basement affords space at the western end for photographic dark rooms and enlarging room, emulsion room, constant temperature room (including space for clocks), physical laboratory, and concave grating room; and at the eastern end for optical, instrument, and pattern shops.

The attic between the two small towers is 104 feet long and 12 feet wide. It is fitted up as a heliostat room. A portion of the roof near the northeast dome is mounted on wheels which run on steel rails. By a windlass this portion of the roof can be drawn to the southward far enough to allow the Sun's rays, at all seasons of the year, to fall upon a heliostat placed near the northern end of the room. A heliostat having a mirror of 24 inches aperture is being made in the shops of the observatory. The large attic rooms along the main axis of the building are so arranged that they can be used in conjunction with the heliostat room for the use of apparatus having lenses or mirrors of great focal length.

The spectroscopic laboratories have solid brick piers on concrete foundations. These are so arranged, with reference to the doors and windows, that the instruments mounted upon them can be used in conjunction with each other, or with instruments in the open air. One of these laboratories is especially arranged for bolometric work. The apparatus for these laboratories includes spectroscopes of various kinds, bolometers, galvanometers, interferential refractometers, induction coils, and a variety of subsidiary apparatus.

The concave grating room is designed to contain a concave grating of 21 feet radius, mounted in the usual manner. At present there are mounted here a 4-inch grating of 10 feet focus and a smaller one of 6 feet focus, both from the Kenwood Observatory. The physical laboratory adjoins the concave grating room, and the latter is so arranged that it can be used in conjunction with apparatus in the former. Both are provided with rolling wooden shutters so that the light can be effectually excluded.

At the Kenwood Observatory, Professor HALE found that many of the problems with which he had to deal, involving, as they did, new methods of research, required the construction of instruments of new and special design. While the principal instruments used there were obtained from BRASHEAR and from WARNER & SWASEY, it was found necessary to have a workshop in which nearly the entire time of an instrument maker was

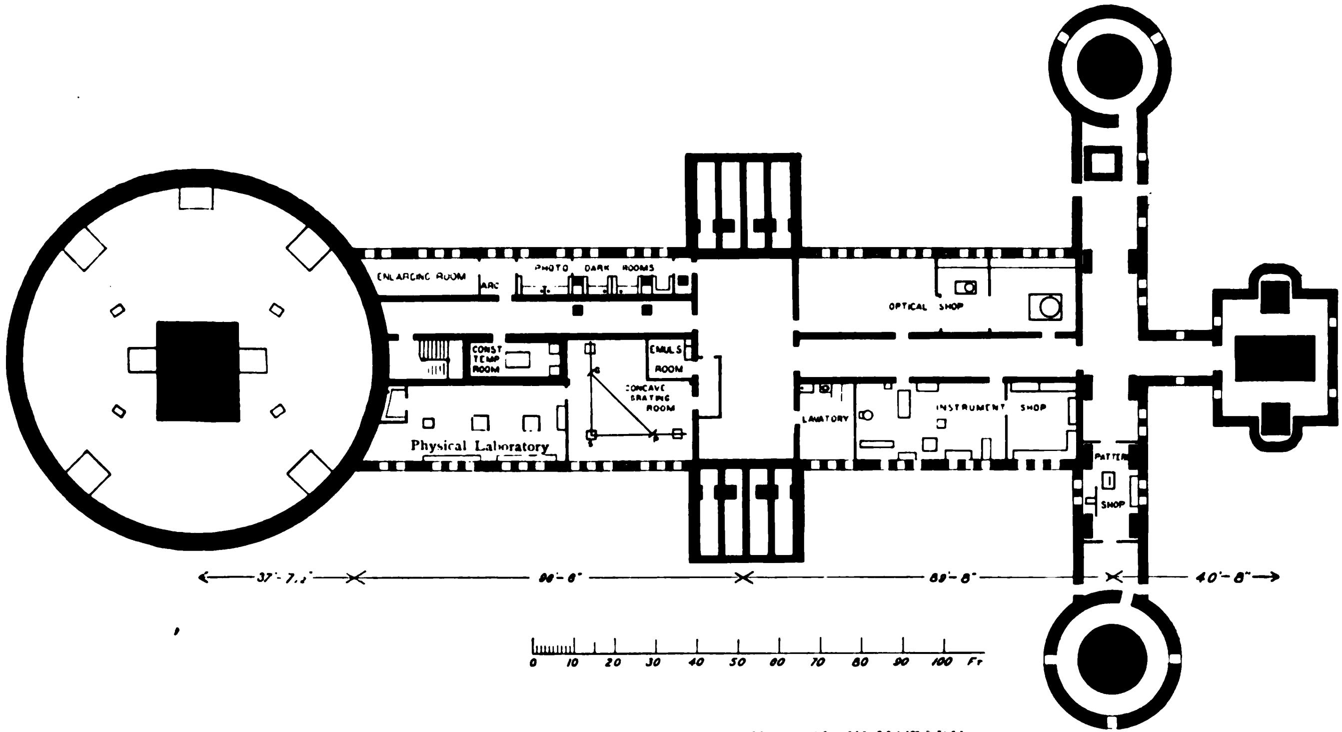
employed in constructing pieces of apparatus required in the solar and spectroscopic work. This shop proved so indispensable to the Kenwood Observatory that it was decided to provide the Yerkes Observatory with the best facilities for mechanical and optical work. A room, 18 by 54 feet, for metal working, was selected on the ground floor of the observatory in the southeast quarter of the building, with smaller adjacent rooms to the east fitted up as a forge room and a pattern shop.

The machine tools used at Chicago were an engine lathe, a shaper, a small speed lathe, an 8-inch Rivett "Precision" lathe, and a Brown & Sharpe universal milling machine. These have been transferred to the new shops, and a planer, a drill press, a circular saw, and speed lathes added.

Two mechanicians are regularly employed in this shop. Several important machines and various pieces of apparatus are in process of construction. A friend of science in Chicago has provided the means of employing a third mechanician for the express purpose of constructing a machine for ruling gratings, according to plans by Professor WADSWORTH.

The optical shop (20 by 70 feet), with rooms fitted up for grinding, polishing and testing lenses and mirrors, is on the north side of the building, just across the hall from the machine shop. The walls of these rooms and the double windows are so constructed as to maintain a nearly constant temperature, a condition necessary for the most successful conduct of the work. Some large pieces of optical work have already been completed in this shop, and still more important ones are planned. A large grinding machine has been constructed under the direction of the observatory optician, Mr. G. W. RITCHEY, for the purpose of grinding and polishing a 60-inch mirror, to be used for stellar spectroscopic work. The work of rough grinding has already been undertaken.

The 40-inch telescope, with its dome and elevating floor, are the principal attractions of the Yerkes Observatory, viewed from a popular standpoint. These are the largest in the world. The dome is 90 feet in diameter, 60 feet high above the top of the tower upon which it rests, or 112 feet above the ground. Its framework is of steel, riveted together. This is covered, first, with a sheathing of wood, and next with roofing tin. It is supported upon 36 wheels, each 36 inches in diameter, and is turned by an endless cable which passes around the dome and is connected with the driving mechanism. The cable is driven



GROUND FLOOR OF THE YERKES OBSERVATORY.

by an electric motor, controlled by a switch on the observing floor. Provision is also made for revolving the dome by hand. The wheels upon which the dome revolves have journals with roller bearings for relieving the friction, and are so constructed as to adjust themselves to possible inequalities of the track.

The observing slit is 13 feet wide, and extends from the horizon to a point 5 feet beyond the zenith. The shutters covering this opening are arranged to open simultaneously on either side, and remain parallel in all positions. Adjustable canvas curtains are placed within the opening to protect the telescope, in whatever direction it may be pointed, from the wind.

It is of interest to compare this dome with the one the next largest; namely, that of the Lick Observatory. The large dome at Mt. Hamilton has an outside diameter of 74 feet 4 inches, and an inside diameter of 71 feet, and weighs, including shutters and live ring, 99½ tons. The live ring itself weighs 12½ tons. This dome rises 41 feet 8 inches above the top of the supporting tower, and 76 feet 10 inches above the ground. The dome is supported on a live ring consisting of 21 conical rollers, each roller having three wheels. The base plate of the dome rests on the central wheel of each group, while the outside wheels rest upon the lower track. The two rails of this track are a part of a conical surface with its apex in the vertical axis of the dome, and in the plane with the tops of the rollers. The upper track is a plane surface. The outside wheels of the live ring are 30 inches in diameter, and the inside ones 28½ inches. The three wheels of each roller were pressed on a steel spindle 3½ inches in diameter, and the journals at the extremities of these spindles are provided with roller bearings for avoiding sliding friction. The framework of the dome is of steel construction, and it is covered with galvanized steel plates.

The observing slit is 9 feet 6¾ inches in the clear, and extends from near the horizon to a point 3½ feet beyond the zenith. This opening is closed with double shutters, hinged at a point beyond the zenith, and supported on wheels resting on a track below. These shutters open simultaneously, but do not remain parallel. The dome is turned by a cable, operated by an hydraulic engine. It may also be turned by hand.

The elevating floor of the Yerkes Observatory is 75 feet in diameter, and rises through 22 feet. It is supported by wire cables, 90° apart. These cables pass over large drums, and are

attached to counterweights. Gearing connects the four drums, causing them to operate simultaneously. The floor is operated by an electric motor, controlled by a switch on the floor. The rising floor of the Lick Observatory was the first one installed. It is 61½ feet in diameter, and rises through 16½ feet. It is operated by hydraulic rams placed 90° apart, and is provided with gearing to keep the floor level in all positions. This method of operation was out of the question at the Yerkes Observatory on account of the danger of the water in the rams freezing in the severe winter weather at Lake Geneva. At Mt. Hamilton the temperature is usually above 32° Fahrenheit, even in winter, and there is seldom any danger from freezing.*

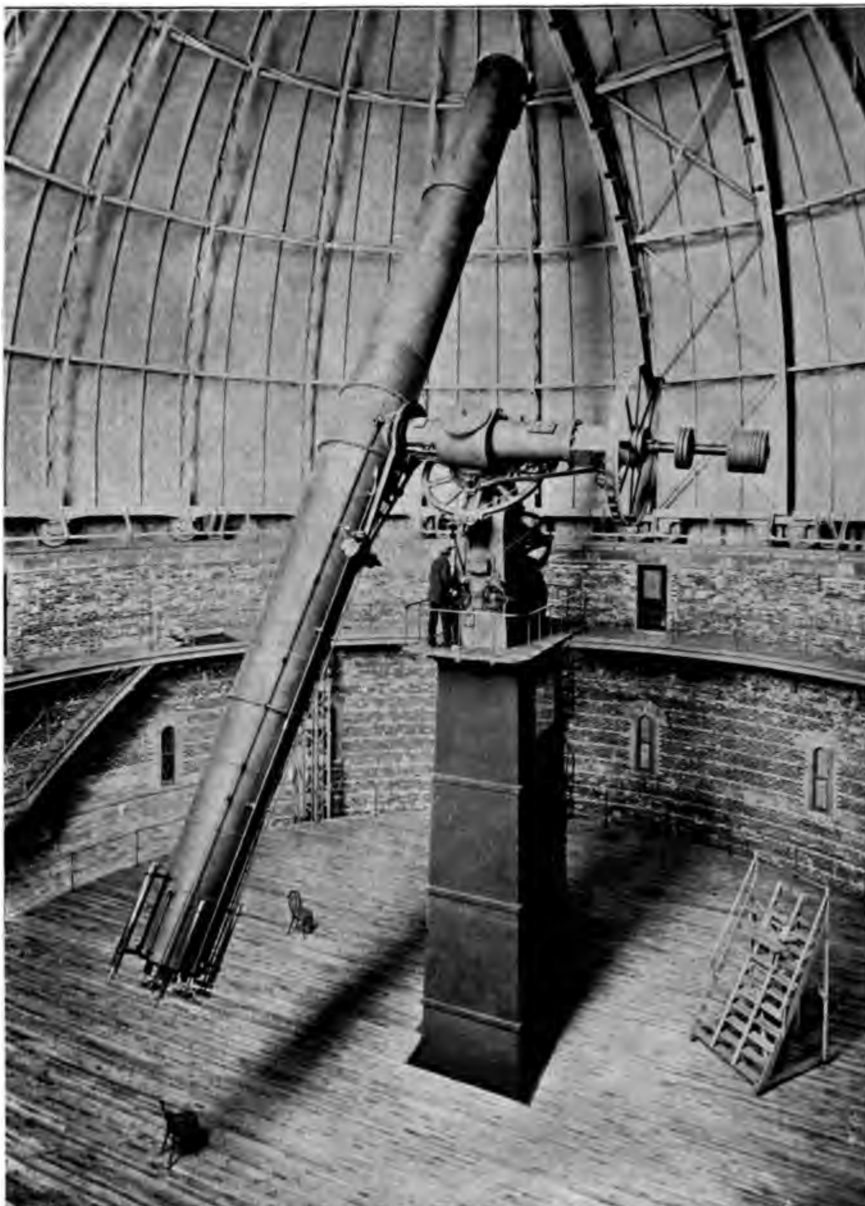
The objective of the Yerkes telescope is 40 inches in diameter, and has a focal length of 62 feet. The crown lens is 2½ inches thick at the center, and ¾ inch at the edge, and weighs 200 pounds. The flint lens is about 1½ inches thick at the center, and 2 inches at the edge, and weighs more than 300 pounds. The two lenses are mounted 8⅜ inches apart, upon aluminum bearings in a cast-iron cell. The total weight of the objective in its cell is about 1000 pounds.

The objective was completed in September, 1895, and tested in the following month at the CLARKS' factory at Cambridgeport, Mass., by Professors HALE and KEELER. Professor KEELER acted as "expert agent" in making the test, and in his report he states:—

"The expanded star disk was round inside and outside of the focus, uniformly illuminated, and free from wings or other appendages. Good images at the focus were obtained of stars at widely different altitudes near the meridian, the definition being,

* The following table is derived from the record of the minimum thermometer at the Lick Observatory. It gives a summary of the lowest temperatures for the past six years. The months considered are from November to March, inclusive, the five coldest months of the year.

WINTER.	MIN. TEMP.	AV. MIN.	NUMBER OF DAYS WHEN TEMPERATURE FELL BELOW			
			20°	25°	30°	32°
1891–92	+17°	+38°	2	5	22	33
92–93	22	37	0	9	32	59
93–94	16	36	4	16	45	56
94–95	22	39	0	4	24	40
95–96	18	39	1	7	28	36
96–97	18	34	2	14	42	52



THE FORTY-INCH YERKES TELESCOPE, MAY 11, 1897.

in my opinion, with due allowance for atmospheric disturbance, equal to that of the Lick telescope, while the brightness of the image was, of course, considerably greater than with the latter instrument. . . . . The color correction of the 40-inch objective is, according to my best recollection, almost precisely the same as that of the Lick telescope."

The tube of the telescope is 60 feet long. It has a diameter of 52 inches at the center, 42 inches at the objective, and 38 inches at the eye-end. It is made of sheet steel, increasing in thickness from 1/8 inch at the ends to 7/32 at the center. It weighs 6 tons, and is so designed that it is in perfect balance when a spectroscope weighing half a ton is attached to the eye-end. When the spectroscope is removed, as for micrometer work, the balance is restored by clamping weights near the eye-end.

The polar and declination axes are of hard forged steel. The former is 13½ feet long, 15 inches in diameter at the upper bearing, and 12 inches at the lower bearing, and weighs 3½ tons. The latter is 11½ feet long, 12 inches in diameter, and weighs 1½ tons. The bearings of these axes are relieved by live rings of steel rolls, to reduce the friction.

The telescope is supported by a cast-iron column, made in sections, bolted together, and firmly anchored to a massive brick pier resting on a concrete foundation. The equatorial head at the top of the column is cast in a single piece, and rises 43 feet above the lowest position of the moving floor. The column and head together weigh 50 tons. An iron balcony surrounds the head. It is accessible from the floor by means of a spiral stairway at the south side of the column. The driving clock is placed within the column, and is accessible by this stairway. An electric motor automatically winds the clock when the weight reaches a point near the limit of its run.

The clamps and slow motions can be operated by an observer at the eye-end, or by an assistant on the balcony. Rapid motions are also provided, as well as a complete system of electric motions, clamps, and illumination. The accessories are a filar micrometer by WARNER & SWASEY, a solar spectroscope and spectroheliograph from designs by Professors HALE and WADSWORTH, and a stellar spectroscope designed and constructed by BRASHEAR.

The objective of the Lick telescope is 36 inches in diameter, and has a focal length of 57 feet 10 inches. The crown

lens is 1.96 inches thick at the center and 0.60 inch at the edge. The flint lens is 0.93 inch thick at the center and 1.65 inches at the edge. The two lenses are mounted about 6½ inches apart, and the total weight of the objective in its cell is 532 pounds.

The tube is 52 feet long, 48 inches in diameter at the center and 38 inches at the ends. It is constructed of sheet steel, 3/16 inch thick at the center and diminishing to ⅛ inch at the ends. The tube has an extension at the eye-end of smaller diameter. This is nearly 3 feet long, and is arranged to carry the sleeve for supporting spectroscopes, photographic apparatus, and the draw tube for the micrometer. The weight of the tube and attachments is 5.3 tons.

The polar and declination axes are of steel; the former is 10 feet long, 12 inches in diameter, and weighs with its attachments 2½ tons; the latter is 10 feet long, 10 inches in diameter, and weighs, with its attachments, 2 tons. The total weight that moves when turning in declination is 7¼ tons, and when moving in right ascension is 14½ tons (28,847 pounds).

The iron columns and heads of the Lick and Yerkes telescopes are similar in design. The head and attachments of the former weigh 6½ tons, the column 19 tons, and the driving clock 1 ton, and total weight of its stationary parts 26¼ tons. The driving clock is wound by a water motor.

In considering the great telescopes of the Yerkes and Lick Observatories, the large increase in the dimensions and massiveness of the former, as compared with the latter, stands in striking contrast with the comparatively small increase in the diameter and focal length of the objective. The objectives differ only 4 inches in diameter and about 4 feet in focal length; the Yerkes telescope weighs 75 tons, and the Lick telescope 41 tons; the elevating floor of the former is 75 feet in diameter and weighs 37½ tons, that of the latter is 61½ feet in diameter and weighs 26 tons; the dome of the former is 90 feet in diameter and weighs 140 tons, while that of the latter is 75 feet in diameter and weighs 99½ tons. The principal reason that the differences are so great is, that the Yerkes telescope has been designed to carry an exceedingly long and heavy solar spectroscope, and other large instruments at the eye-end. This

made it necessary to increase the height and massiveness of the mounting, the distance through which the moving floor rises and falls, and the available floor space beyond what would otherwise have been ample.

Leaving out of account the question of absorption as dependent upon the thickness of the lenses, the perfection with which they are polished, and the quality of the glass of which they are made, in so far as it affects transparency, the light gathering power of the Yerkes telescope is to that of the next largest telescope in the ratio of 100 to 81, or very nearly in the ratio of 5 to 4. This is a difference which, other things being equal, will give it a great advantage over all other instruments in many kinds of work. The magnitudes of the faintest stars visible in the Yerkes and Lick telescopes are (neglecting absorption) respectively 17.21 and 16.98*, or the difference is less than a quarter of a magnitude. In defining power, as exemplified in the separation of close double stars, the two instruments stand in the ratio of 10 to 9; the theoretical limit of separation for the former is $0''.12$ and that for the latter $0''.13$†. These limits differ so little, and are in themselves so small, that in defining power the one telescope has scarcely any advantage over the other for the work here considered. Besides, the practical realization of these limits, aside from the skill of the observer, will depend almost entirely upon atmospheric conditions, particularly upon the steadiness of images and the excellence of the seeing.

The Yerkes Observatory is valued at about $400,000. The large objective cost $66,000; the mounting, $55,000; the dome and elevating floor, $45,000; the stellar spectroscope, $3000; the building, power house, engines, dynamos, etc., more than $145,000. These were the gifts of Mr. YERKES. Mr. JOHNSON's gift of land is valued at $50,000; Mr. W. E. HALE's gift of the Kenwood Observatory, $30,000; Miss BRUCE has given $7000 for a 10-inch photographic telescope.

The Lick Observatory cost nearly $600,000. The objective of the 36-inch telescope cost $50,000; the third lens (photographic corrector), 33 inches in diameter, $13,000; the mount-

* This assumes that the faintest star visible in a 1-inch telescope is 9.2 magnitude.

† This assumes, as usual, that the spurious disk of a star in a 12-centimeter telescope is 1" in diameter.

ing, $42,000; the elevating floor, $13,000; and the large dome, $54,000.*

In his address at the dedication, President HARPER, quoting the Director, said: "The policy of the Yerkes Observatory will be: (1) To derive the greatest possible return from the use of the great telescope. It is evident that special attention should be given to micrometrical observations of stars, satellites, comets, nebulæ, etc.; solar investigations, both visual and photographic; and spectroscopic researches on the nature of the stars and their motion in the line of sight. (2) To provide for the investigation of any phase of an astronomical or related physical problem. Most American observatories are unprovided with the instruments and laboratories necessary for the interpretation of the phenomena constantly encountered in spectroscopic observations of the heavenly bodies. Spectroscopic laboratories, on the other hand, are not equipped to carry their investigations beyond the artificial boundaries of physics into the realm of astronomy. It is hoped that the Yerkes Observatory may ultimately be in a position to represent both the astronomical and physical sides of astrophysical work, and at the same time provide the best facilities for research work in astronomy of position."

The illustrations accompanying this article are from *The Astrophysical Journal*. They were obtained through the courtesy of Professor HALE.

LICK OBSERVATORY, Mt. Hamilton, Cal.,
November 23, 1897.

* At the present time the prices of telescopes of various sizes, without their domes and buildings, are roughly as follows, varying much, of course, with the style of mounting, the accessories provided, and the quality of the workmanship. The accessories here included are micrometer, spectroscope, finder, and eye pieces.

DIAMETER OF OBJECTIVE.	PRICE OF OBJECTIVE.	PRICE OF MOUNTING.	ACCESSORIES.	TOTAL.
45 inches	$80,000	$65,000	$4,000	$149,000
40 "	66,000	55,000	4,000	125,000
36 "	40,000	40,000	4,000	84,000
30 "	25,000	30,000	3,500	58,500
24 "	14,000	20,000	3,000	37,000
20 "	9,000	9,000	2,500	20,500
16 "	4,500	6,500	2,500	13,500
12 "	2,000	4,500	2,000	8,500

CATALOGUES NOS. III AND IV, OF NEBULÆ DISCOVERED AT THE LOWE OBSERVATORY, ECHO MOUNTAIN, CALIFORNIA.

BY DR. LEWIS SWIFT, DIRECTOR.

LIST III.

No.	Date of Discovery.		R. A.	Dec. for 1900.	Description.
	1897		h m s	° ′ ″	
1	Aug.	10,	0 46 45	— 35 0 43	pB eeS E. with 132 & 200 looks like a nebulous D *Uranus*.
2	Sept.	4,	0 55 0	— 40 53 51	vF. vS. R.
3	Sept.	4,	1 9 45	— 33 11 33	eeF. S. eeE. a ray no * near.
4	Sept.	4,	1 23 35	— 36 17 3	eeF. pS. R. vdif.
5	Sept.	4,	1 33 10	— 34 29 45	vF. S. R. eF. * near nf.
6	Sept.	6,	1 46 45	— 30 26 20	pB. eS. lE. like a D nebulous * with 132 & 200. See No. 1.
7	Sept.	6,	1 53 45	— 33 46 44	eeeF. ps. R. 7^m * in field nf. another suspected.
8	Sept.	4,	2 6 0	— 33 29 40	vF. S. vE. one * nr.
9	Sept.	5,	2 11 0	— 31 41 30	pB. pS. lE.
10	Sept.	6,	2 34 3	— 27 52 25	pB. CS. R. 8^m * pretty close p.
11	Sept.	5,	2 44 30	— 31 42 30	vF. pS. R. 1^{st} of 3.
12	Sept.	5,	2 44 32	— 31 36 32	vF. pS. R. 2^d of 3.
13	Sept.	5,	2 45 4	— 31 36 32	pF. pS. lE. 3^d of 3.
14	July	22,	20 19 10	— 31 11 37	eF. pS. lE. wide D * near s.
15	July	25,	20 20 50	— 36 20 57	pB. vS. eE.
16	Aug.	29,	20 22 0	— 36 22 19	eeS. eE. in meridian.
17	Aug.	29,	20 24 30	— 33 50 57	pF. pS. lE.
18	Aug.	29,	20 36 50	— 30 11 30	vF. pS. R. 2F st. nr nf point to it. 1^{st} of 3.
19	Aug.	29,	20 37 5	— 30 11 30	eeF. CS. eE. nr the p * of several in segment of a circle. 2^d of 3.
20	Aug.	29,	20 37 30	— 30 1 30	eeeF. pS. vE. eeedif. 3^d of 3.
21	July	9,	21 26 5	— 37 9 9	eF. pS. R. an e wide D * f 30^s.
22	Aug.	31,	22 3 5	— 28 21 11	eeF. vS. vE. forms right angle 2vF close stars.
23	Aug.	8,	22 36 0	— 45 19 15	pF. pL. R. F * nr sf.
24	Sept.	4,	22 51 10	— 37 7 5	eeF. vS. eeeE. a ray almost a line. np of 1459 Index Cat. Barnard.
25	Sept.	4,	22 52 20	— 36 35 2	vF. vS. R. sf of 2.
26	Sept.	4,	22 52 30	— 36 24 0	pB. pS. R. np of 2.
27	Aug.	8,	23 13 50	— 42 49 45	eeF. S. CE. f of 3. f 7599.
28	Aug.	8,	23 16 15	— 43 3 20	eeeF. pL R. 10^m * nr s. 11^m * f. eeedif.
29	Aug.	8,	23 23 8	— 42 2 0	pB. pS. R. 9^m * close s.
30	Aug.	8,	23 26 59	— 45 36 18	vF. vS. R. bet 2 st. 8^m * sp.

NOTES.

List No. 1, of fifty nebulæ discovered here, was published in the *Astronomical Journal* of November 13, 1896. List No. 2, of twenty-five, was recently published in *Monthly Notices*, and *Publications* A. S. P. The present list, as will be seen, consists of southern nebulæ exclusively. It is a field rich in nebulæ, which that mighty Nimrod, Sir WILLIAM HERSCHEL, who hunted the sky over, could not reach. Several are quite bright, and a few are interesting. I have examined GALES' ring nebula, R. A. 21^h 53^m 10^s, Decl.—39° 53′ 42″, and find it an interesting one, increasing the number now known to seven. It bears considerable resemblance to the one in *Lyra*, but is not as bright, nor will it bear magnifying like that celebrated one, though it is too far south for me to do justice to it. Numbers 1 and 6 are singular specimens of nebulæ, perhaps deserving of a new classification. I have lately seen three, all looking exactly alike.

N. G. C. 1288 is considerably elongated in 0°. It is not round, as Sir JOHN HERSCHEL says.

N. G. C. 1340 must be struck out. It is identical with 1344, as has been suspected. I examined the locality thoroughly for 1340, and I am certain that it does not exist. Some time I intend to take up this matter of doubtful nebulæ.

I am glad I have at length found in BARNARD'S field a nebula his keen eye failed to see. See No. 24.

LIST IV.

No.	Date of Discovery.	R. A.	Dec. for 1900.	Description.
		h m s	° ′ ″	
1	Sept. 23,'97	0 11 0	— 39 52 20	eeeF. vL eE. close f 55. See note.
2	Oct. 3, "	0 54 30	— 34 51 32	pB. vS. R. 2 st nf. & 2 np.
3	Sept. 29, "	1 5 0	— 46 31 38	vF. S. R. No B * near. vF one f.
4	Sept. 29, "	1 53 4	— 33 31 27	pB. vS. R. BM. 10^m * v close sp.
5	Sept. 29, "	2 5 0	— 33 25 0	vF. vS. eE. nearly 0°. F * p.
6	Sept. 29, "	2 59 28	— 39 52 38	eF. pS. R. F D * sf points to it.
7	Sept. 26, "	3 31 0	— 34 46 55	pB. S. eeeE. a straight hair-like line [illegible] See note.
8	Sept. 29, "	4 8 45	— 33 7 51	eF. vS. R. BM. 10^m * close s.
9	Sept. 29, "	4 16 30	— 31 41 42	eeF. pL. R.
10	Aug. 10, "	19 53 30	— 38 47 38	vF. S. R. 8^m * f 90°. p of 2. same parallel
11	Aug. 10, "	19 54 0	— 38 47 38	vF. S. R. 8^m * f. f of 2.
12	July 8, "	20 0 0	— 48 35 50	B. CE. vS. stellar. f of 2.
13	Sept. 23, "	20 10 59	— 41 53 24	vF. CS. R. no B * near.

	Date of Discovery.	R. A.	Dec. for 1900.	Description.
		h m s	° ′ ″	
14	Sept. 16, "	20 24 25	— 36 39 15	vF. CS. R. several p B st s & f.
15	Sept. 17, "	20 40 25	— 38 50 35	eeF. pS. R.
16	Sept. 15, "	21 1 31	— 30 26 30	eeF. pS. R. F * near f 90°.
17	Sept. 17, "	21 41 0	— 35 21 58	vF. vS. R.
18	Sept. 17, "	21 42 0	— 35 27 0	vF. pL. R. Not 7130, or 7135. sp of 2.
19	Sept. 17, "	21 43 30	— 35 22 10	eeF. pL. R. 3 B st p = Δ. nf of 2.
20	Sept. 27, "	21 49 46	— 49 31 52	eeF. pS. R. in line with 2 9^m St sf. 7^m * in field sf.
21	Sept. 23, "	22 51 30	— 43 59 27	pB. S. R. mbM.
22	Oct. 3, "	23 27 45	— 45 35 40	vF. S. R. bet 2 st. 8^m * sf. & a 7^m * sp.
23	Sept. 23, "	23 39 25	— 43 29 15	vF. eS. R. stellar.
24	Sept. 25, "	23 42 40	— 37 36 53	eeF. CS. R. in vacancy.
25	Sept. 25, "	23 52 25	— 37 34 52	pB. CS. eE. 1 * near sf.

NOTES.

The nebulæ in this list, the fourth issued from this observatory, bringing the total to 130, are, as will be seen, all southern nebulæ. They are, with few exceptions, very faint, though some are bright enough to come under HERSCHEL'S Class I. That these have not been previously found, shows that the southern sky, including that portion within the reach of Sir WILLIAM HERSCHEL and LORD ROSSE, has not been as thoroughly searched over as has been the northern.

No. 1 = G. C. 27; also, N. G. C. 55, is, with its associated companion, a very remarkable nebula. I am at a loss what to think of it, whether it is all one; the preceding half very bright, very large, exceedingly elongated, the following half exceedingly faint, equally as large, and still more elongated; or, whether they are two distinct nebulæ, one partly overlapping the other. If single, it is curved; if double, they are inclined to each other. I am inclined to think they are two distinct nebulæ, one reason being that the brighter one ends sharply, which would hardly be the case if the brighter merged into the fainter. The brighter was discovered by DUNLOP, but I doubt if he could have seen the fainter. That Sir JOHN HERSCHEL does not mark it with a sign, as he often has done, meaning a very remarkable or even a remarkable object, lends plausibility to the idea that the fainter was not even seen by him. As, however, it has been illustrated, a reference to that would decide the matter at once.

No. 7. This, in one respect at least, is the most remarkable nebula I have ever seen. I doubt if the entire heavens afford a similar example. If the reader will cut off a short piece of fine, bright brass wire, and hold it up sidewise to the sky, he will form, by looking at it, a very correct idea of how it appeared to me. The line was certainly nebulous. It must be a thin nebulous disk seen exactly edgewise.

G. C. 383 does not exist, and must be struck out. Sir JOHN HERSCHEL makes both 380 and 383 of equal brightness, and the places given would place both well within my field of 31′ in diameter, power 132. I made a long and thorough search for 383, and would have found it if there, had it been three times fainter than 380, which is an easy object.

PLANETARY PHENOMENA FOR JANUARY AND FEBRUARY, 1898.

By Professor Malcolm McNeill.

January.

Eclipses. 1898 is richer in eclipses than was 1897. There will be six in all, divided equally between those of the Sun and those of the Moon, and one of each will occur in January.

The first will be *a partial eclipse of the Moon*, and will occur on January 7th. It will be visible in the eastern hemisphere and in the eastern part of the United States, but the Moon will have passed out of the Earth's shadow before moonrise in the western part of the United States. The maximum obscuration is less than one sixth of the Moon's diameter.

The second will be *a total eclipse of the Sun* on the morning of January 22d. No part of it will be visible in the western hemisphere. The line of totality begins in Central Africa, and passes through the Indian Ocean, India, and China. The most accessible part of the Earth for observations is India, and the weather conditions are usually favorable at that time of the year. A large number of expeditions from various parts of the world will be sent to make observations. The duration of the eclipse will be about two minutes.

Occultations. The Moon will pass over the *Pleiades*, and a considerable number of occultations may be seen from almost any part of the United States on the evening of January 30th.

Mercury is an evening star at the beginning of the month, setting not quite an hour after sunset. It rapidly approaches the Sun, passes inferior conjunction on January 6th, and becomes a morning star. By the middle of the month, it rises early enough to be seen in the morning twilight, and it reaches its greatest west elongation on the morning of January 29th, when it rises nearly an hour and a half before sunrise.

Venus is a morning star, quite near the Sun throughout the month, and cannot be seen, except, possibly, for a few days at the beginning. On January 31st it rises only a few minutes before sunrise.

Mars is also a morning star, very close to *Venus* at the beginning of the month, less than one degree west and north; but instead of getting nearer the Sun, as *Venus* does, it moves away from it, and at the end of the month it rises about an hour before sunrise. Its distance from the Earth has begun to diminish slightly, but not enough to cause much increase in brightness.

Jupiter rises at about midnight on January 1st, and two hours earlier on January 31st. It is a little east and south of the third magnitude star γ *Virginis*, and moves eastward about one degree until January 24th, when it begins to retrograde.

Saturn is a morning star, rising somewhat earlier than *Mars* and *Venus*. It is in the constellation *Scorpio*, about six degrees north of the red first magnitude star, *Antares*, and during the month moves about three degrees eastward.

Uranus precedes *Saturn* about six degrees, and is about one degree south of β *Scorpii*. It is also moving eastward, but less than half as fast as *Saturn*.

Neptune is in the eastern part of *Taurus*.

FEBRUARY.

Mercury is a morning star throughout the month, and during the first half of the month rises early enough to be seen in the morning twilight, if the atmospheric conditions are good. It makes a very near approach to *Mars* on February 11th, *Mercury* passing to the north of *Mars* at a distance of only one minute of arc. The Sun will have risen for all parts of the United States

before the time of the nearest approach, but the planets will be near enough to be seen together in a telescope with a moderately large field of view, on the morning of that date before sunrise.

Venus is a morning star at the beginning of the month, but passes superior conjunction on the morning of February 15th, and becomes an evening star. It does not, however, reach a distance from the Sun sufficient for naked-eye observation until some time after the end of February.

Mars is also a morning star, rising a little earlier than during January. It is slowly approaching the Earth, but it is still distant from us more than double the Earth's mean distance from the Sun, and it will not be conspicuous until nearly the close of the year.

Jupiter is rising about two hours earlier than during the corresponding time in January, and by the end of the month is up in time for late evening observations. It moves westward during the month about two degrees from a position east of the third magnitude star, γ *Virginis*, to a position about the same distance west. At the time of nearest approach, the star is a little more than one degree north of the planet.

Saturn is still a morning star, but rises earlier at the end of the month, shortly after one o'clock. It moves about two degrees eastward in the constellation *Scorpio*, and is north and east of the red star *Antares*, the brightest star of the constellation. The apparent outer minor axis of the ring is nearly half the major axis, not far from the widest opening the rings can have.

Uranus precedes *Saturn* about nine degrees, and is about one degree east and south of β *Scorpii*. Its motion during the month is small, about half a degree eastward, until February 28th; then it begins to retrograde.

Neptune is in the eastern part of *Taurus*, and remains above the horizon until after midnight.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by

the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

PHASES OF THE MOON, P. S. T.

			H. M.
Full Moon,	Jan.	7,	4 24 P. M.
Last Quarter,	Jan.	15,	7 44 A. M.
New Moon,	Jan.	21,	11 25 P. M.
First Quarter,	Jan.	29,	6 33 A. M.

THE SUN.

1898.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Jan. 1.	18 49	− 22 59	7 27 A.M.	12 4 P.M.	4 41 P.M.
11.	19 32	− 21 46	7 26	12 8	4 50
21.	20 15	− 19 50	7 22	12 12	5 2
31.	20 57	− 17 17	7 14	12 14	5 14

MERCURY.

Jan. 1.	19 35	− 20 16	8 2 A.M.	12 50 P.M.	5 38 P.M.
11.	18 45	− 19 40	6 31	11 21 A.M.	4 11
21.	18 36	− 20 51	5 48	10 33	3 18
31.	19 12	− 21 47	5 47	10 29	3 11

VENUS.

Jan. 1.	18 1	− 23 27	6 41 A.M.	11 16 A.M.	3 51 P.M.
11.	18 56	− 23 13	6 56	11 32	4 8
21.	19 50	− 21 49	7 4	11 46	4 28
31.	20 43	− 19 19	7 8	12 0 M.	4 52

MARS.

Jan. 1.	17 58	− 24 4	6 41 A.M.	11 13 A.M.	3 45 P.M.
11.	18 31	− 23 58	6 35	11 7	3 39
21.	19 4	− 23 27	6 25	11 0	3 35
31.	19 37	− 22 29	6 15	10 54	3 33

Jupiter.

1898.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Jan. 1.	12 37	− 2 32	12 2 A.M.	5 53 A.M.	11 44 A.M.
11.	12 39	− 2 43	11 25 P.M.	5 16	11 7
21.	12 40	− 2 47	10 47	4 38	10 29
31.	12 40	− 2 43	10 7	3 58	9 49

Saturn.

Jan. 1.	16 24	− 19 53	4 51 A.M.	9 40 A.M.	2 29 P.M.
11.	16 29	− 20 2	4 16	9 5	1 54
21.	16 32	− 20 10	3 41	8 30	1 19
31.	16 36	− 20 16	3 6	7 54	12 42

Uranus.

Jan. 1.	15 59	− 20 21	4 26 A.M.	9 14 A.M.	2 2 P.M.
11.	16 1	− 20 27	3 50	8 37	1 24
21.	16 2	− 20 32	3 13	8 0	12 47
31.	16 4	− 20 36	2 35	7 22	12 9

Neptune.

Jan. 1.	5 19	+ 21 44	3 15 P.M.	10 33 P.M.	5 51 A.M.
11.	5 19	+ 21 43	2 35	9 53	5 11
21.	5 17	+ 21 42	1 55	9 13	4 31
31.	5 17	+ 21 42	1 14	8 32	3 50

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off left-hand limb, as seen in an inverting telescope.)

		H. M.			H. M.
II, D,	Jan. 2.	10 16 P. M.	II, D,	Jan. 17.	3 26 A. M.
I, D,	3.	5 13 A. M.	I, D,	19.	3 27 A. M.
I, D,	4.	11 41 P. M.	I, D,	20.	9 55 P. M.
III, R,	7.	9 2 P. M.	III, D,	22.	2 10 A. M.
II, D,	10.	12 51 A. M.	III, R,	22.	4 56 A. M.
IV, D,	10.	12 51 A. M.	II, D,	24.	6 2 A. M.
IV, R,	10.	2 39 A. M.	I, D,	26.	5 20 A. M.
I, D,	12.	1 34 A. M.	IV, R,	26.	8 25 P. M.
III, D,	14.	10 12 P. M.	I, D,	27.	11 48 P. M.
III, R,	15.	12 59 A. M.	III, D,	29.	6 8 A. M.

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Jan. 3.	7 43 A. M.	Jan. 20.	12 36 P. M.
6.	4 32 A. M.	23.	9 25 A. M.
9.	1 21 A. M.	26.	6 14 A. M.
11.	10 10 P. M.	29.	3 3 A. M.
14.	6 59 P. M.	31.	11 52 P. M.
17.	3 47 P. M.		

Phases of the Moon, P. S. T.

		H. M.
Full Moon,	Feb. 6,	10 24 A. M.
Last Quarter,	Feb. 13,	4 35 P. M.
New Moon,	Feb. 20,	11 41 A. M.
First Quarter,	Feb. 28,	3 13 A. M.

The Sun.

1898.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Feb. 1.	21 1	−17 0	7 13 A.M.	12 14 P.M.	5 15 P.M.
11.	21 41	−13 55	7 2	12 14	5 26
21.	22 19	−10 26	6 50	12 14	5 38
Mar. 3.	22 57	− 6 42	6 35	12 12	5 49

Mercury.

Feb. 1.	19 17	−21 48	5 48 A.M.	10 30 A.M.	3 12 P.M.
11.	20 12	−20 57	6 0	10 45	3 30
21.	21 13	−18 1	6 10	11 7	4 4
Mar. 3.	22 18	−12 53	6 18	11 33	4 48

Venus.

Feb. 1.	20 48	−19 1	7 8 A.M.	12 1 P.M.	4 54 P.M.
11.	21 38	−15 30	7 6	12 12	5 18
21.	22 27	−11 16	7 0	12 21	5 42
Mar. 3.	23 14	− 6 33	6 50	12 28	6 6

Mars.

Feb. 1.	19 40	−22 22	6 13 A.M.	10 53 A.M.	3 33 P.M.
11.	20 12	−20 58	6 1	10 46	3 31
21.	20 44	−19 10	5 47	10 39	3 31
Mar. 3.	21 16	−17 3	5 30	10 31	3 32

Jupiter.

Feb. 1.	12 40	− 2 42	10 3 P.M.	3 54 A.M.	9 45 A.M.
11.	12 38	− 2 30	9 22	3 13	9 4
21.	12 36	− 2 11	8 39	2 32	8 25
Mar. 3.	12 32	− 1 47	7 55	1 49	7 43

Saturn.

Feb. 1.	16 36	−20 17	3 2 A. M.	7 50 A.M.	12 38 P.M.
11.	16 39	−20 21	2 26	7 14	12 2
21.	16 41	−20 25	1 49	6 36	11 23 A.M.
Mar. 3.	16 43	−20 26	1 12	5 59	10 46

Uranus.

Feb. 1.	16 4	−20 36	2 31 A.M.	7 18 A.M.	12 5 P.M.
11.	16 5	−20 39	1 53	6 40	11 27 A.M.
21.	16 6	−20 41	1 14	6 1	10 49
Mar. 3.	16 6	−20 42	12 35	5 22	10 9

Neptune.

1898.	R. A. H. M.	Declination. °	Rises. H. M.	Transits. H. M.	Sets. H. M.
Feb. 1.	5 17	+ 21 42	1 10 P.M.	8 28 P.M.	3 46 A.M.
11.	5 16	+ 21 42	12 30	7 48	3 6
21.	5 16	+ 21 42	11 51 A.M.	7 9	2 27
Mar. 3.	5 16	+ 21 43	11 11	6 29	1 47

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off left-hand limb, as seen in an inverting telescope.)

		H. M.			H. M.
II, D,	Feb. 3.	9 56 P. M.	III, R,	Feb. 19.	8 42 P. M.
I, D,	4.	1 41 A. M.	I, D,	19.	11 56 P. M.
I, D,	5.	8 10 P. M.	I, D,	21.	6 24 P. M.
II, D,	11.	12 32 A. M.	II, D,	25.	5 44 A. M.
I, D,	11.	3 34 A. M.	III, D,	26.	9 58 P. M.
I, D,	12.	10 3 P. M.	I, D,	27.	1 49 A. M.
II, D,	18.	3 8 A. M.	II, D,	28.	7 2 P. M.
I, D,	18.	5 28 A. M.	I, D,	28.	8 17 P. M.

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Feb. 3.	8 41 P. M.	Feb. 18.	4 45 A. M.
6.	5 30 P. M.	21.	1 34 A. M.
9.	2 19 P. M.	23.	10 23 P. M.
12.	11 8 A. M.	26.	7 12 P. M.
15.	7 56 A. M.		

COMET *b*, 1897.

By C. D. Perrine.

This comet, the second of the year, was discovered by the writer on the evening of October 16th. It was then in the constellation *Camelopardalis*, in R. A. $3^h\ 36^m\ 7^s.58$, Decl. $+ 66^\circ\ 46'\ 43''.6$, at $17^h\ 45^m\ 22^s$, Greenwich M. T. It was then moving north at the rate of about one and a half degrees per day, and west 6^m. On October 29th it passed within about eight degrees of the pole, and is now moving southward.

The following elements have been deduced from the Mt. Hamilton observations of October 16th, 24th, and 31st:—

$$T = 1897 \text{ Dec. } 8.84714$$

$$\left.\begin{aligned} \omega &= 66^\circ\ 5'\ 42''.2 \\ \Omega &= 32\ \ 4\ \ 4\ .9 \\ i &= 69\ 37\ 40\ .9 \end{aligned}\right\} \text{Ecliptic and mean equinox of 1897.0}$$

$$\log q = 0.132056.$$

The residuals for the middle place being:—

Observed — computed, $\Delta\lambda' \cos\beta' \quad + 4''.1$

$\Delta\beta' \quad + 4\ .3.$

From these elements it will be seen that the comet will make its closest approach to the Sun on December 8th, at a distance of one hundred and twenty-five million miles. Owing to the positions of the Earth and comet in their respective orbits, the comet slowly approached the Earth for about two weeks after its discovery, until it was only about seventy-five million miles away. The distance is now increasing slowly.

At discovery the comet had a clearly-defined stellar nucleus, resembling a twelfth-magnitude star. This nucleus was in and very near the north following end of a well-marked, elongated condensation. Continuing in the same direction as this condensation, *i. e.* s. p., was a narrow streamer of a tail, which could be traced for a distance of 3′ from the head. Around the whole could be seen a faint nebulosity for a distance of probably 1′. In a week's time the star-like nucleus had disappeared, and even the condensation about it had lost much of its light. The changes continued, until by October 31st it was not an easy object to observe with the 12-inch refractor, owing to its blurred appearance — there being no well-marked condensation upon which to set the micrometer wires. At discovery it was quite bright, even in the moonlight, giving as much light as an eighth-magnitude star. On October 31st it was carefully examined with the 36-inch telescope, but no indications of a nucleus were to be seen; there was a long streak of nebulosity in the head, which dwindled into a fainter, streamer-like tail. The size of the comet had changed but little, but instead of being brighter, as it should be, on the assumption that a comet's light is principally reflected sunlight, it was actually very much fainter. Comets frequently show increased activity as they approach the Sun, the nucleus (should the comet show one) becoming much brighter, and in some cases even developing one; but here is a case where the reverse has occurred — the comet losing all signs of the one it had, and losing much of its light, with no sensible change of size. So great has been the loss of light, that it was not found on November 7th (in the moonlight), although the sky for some distance around its place was carefully examined with the 36-inch telescope, using the lowest power available — 270. The orbit of this comet does not resemble that of any known one.

LICK OBSERVATORY, UNIVERSITY OF CALIFORNIA,
November 8, 1897.

ELEMENTS OF COMET *b*, 1897.

By R. Tracy Crawford.

From observations made at the Lick Observatory and telegraphed to the Students' Observatory by Professor J. M. Schaeberle, Acting Director, I have computed the following sets of parabolic elements for Comet *b*, 1897. The first set, from observations by Mr. Perrine on October 16th and 17th, and by Professor Hussey on October 18th, is:—

$$T = 1897 \text{ Dec. } 8.86570 \text{ G. M. T.}$$

$$\left.\begin{aligned} i &= 69^\circ\ 35'\ 39''.5 \\ \Omega &= 32\ \ \ 3\ \ \ 21\ .0 \\ \omega &= 66\ \ \ 6\ \ \ 41\ .4 \end{aligned}\right\} \text{Mean Equinox of 1897.0}$$

$$q = 1.355513$$

Representation of middle place—

$\Delta\lambda \cos\beta = -0''.3$ $\Delta\beta = -1''.0$

$\text{Cot J} = 9.818048_n$ $\text{Cot J}_o = 9.818044_n$

The second set, from observations by Mr. Perrine on October 16th, and by Professor Hussey on October 31st and November 15th, is:—

$$T = 1897 \text{ Dec. } 8.550029 \text{ G. M. T.}$$

$$\left.\begin{aligned} i &= 69^\circ\ 35'\ 51''.5 \\ \Omega &= 32\ \ \ 2\ \ \ 56\ .6 \\ \omega &= 65\ \ \ 48\ \ \ 38\ .0 \end{aligned}\right\} \text{Mean Equinox of 1897.0}$$

$$q = 1.357331$$

Representation of middle place—

$\Delta\lambda \cos\beta = +11''.7$ $\Delta\beta = +19''.6$

$\text{Cot J} = 9.238929_n$ $\text{Cot J}_o = 9.238926_n$

The value of log M used in determining the second set of elements was derived from the first set, as follows:—

$$\log M = 0.064621$$

which agrees exactly with the value of

$$\log M = 0.064621$$

resulting from the second set, so that the second set of elements must be considered as the best parabolic orbit which can be passed through the given observations.

University of California, Students' Observatory,
December 13, 1897.

NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

RESIGNATION OF PROFESSOR E. S. HOLDEN AS DIRECTOR OF THE LICK OBSERVATORY.

At a meeting of the Board of Regents of the University of California, held in San Francisco on Tuesday, October 12, 1897, Professor E. S. HOLDEN'S resignation as Director of the Lick Observatory was presented and accepted, to take effect January 1, 1898.

At the same meeting Professor J. M. SCHAEBERLE was appointed Acting Director during the absence of Dr. HOLDEN.

Professor HOLDEN'S letter was as follows:—

"LICK OBSERVATORY, University of California,
Mt. Hamilton, October 1, 1897.

To the Honorable the Board of Regents of the University of California: —

GENTLEMEN: — I beg to tender my resignation as Director of the Lick Observatory, to take effect at the expiration of my present leave of absence.

In severing my connection with an institution with which I have been intimately connected since the year 1874 (under the direction of the Regents since 1885), I wish to express my obligations to the Board, to the members of the Standing Committees on the Observatory, on Internal Administration, and on Finance, and more especially to the Chairmen of these Committees, for their support, by which alone it has been possible to bring the establishment to its present high state of efficiency.

In the summer of 1874 the President of the first Board of

* Lick Astronomical Department of the University of California.

Lick Trustees visited Washington to consult with Professor NEWCOMB and myself upon the plans for the observatory founded by Mr. LICK. In October of that year I prepared the plans and programme upon which the Lick Observatory has been built, organized, and is now administered. A detailed memorandum on this subject may be found in the *Publications* of the Astronomical Society of the Pacific, Vol. IV, page 139 (1892). The position of Director was offered to me in 1874, and accepted. The plans of the first Board of Lick Trustees were not carried out, for reasons which it is not necessary to state here.

In 1876 I became the adviser of the President of the third Board, and from that time until 1887 all the plans of the buildings were made by me, all the instruments ordered from my specifications (excepting the visual object-glass of the great telescope, with which Professor NEWCOMB was alone concerned), and most of the instruments were mounted and used by me personally during official visits to Mt. Hamilton in the years 1881, 1883, 1885, and 1886. Correspondence on file at the Lick Observatory and in the records of the Lick Trust will exhibit my share in this work.

In December, 1885, I was appointed to be President of the University of California, and Director of the Lick Observatory, and I held the former office until 1888. In June of that year the observatory was formally transferred by the Lick Trustees as the Lick Astronomical Department of the University, and from this time onward its scientific history is known to your Board.

The regular annual income of the observatory has been very small in relation to the wants of the establishment. It has been used to supply these wants so far as possible, and the whole observatory — buildings, instruments, and equipment — is now in excellent condition. Since 1888 the reservoir capacity has been doubled; the buildings have been made water-tight and much improved in many respects; the instruments have been considerably increased in number, and they have been provided with subsidiary apparatus which was lacking; the library has doubled in size; the area of the reservation has been increased by one thousand acres, and the whole establishment and equipment is far more efficient in 1897 than it was in 1888. Only those who have visited the observatory can appreciate the full force of these statements.

A considerable number of graduate students have received

training here, and have been fitted for responsible positions here and elsewhere. Some 50,000 visitors have been received and cared for, and a contribution of importance to the intellectual advancement of the State has thus been made.

A very large part of the strictly scientific work of the observatory has been accomplished by virtue of subsidies received from its friends. Most of its apparatus has been presented to us outright. All of its foreign eclipse expeditions have been sent at the expense of wellwishers of the institution. The expensive plates of the Observatory Moon-Atlas, of Vol. III. of our quarto *Publications*, etc., have been provided at private cost. The names of Messrs. D. O. MILLS, C. F. CROCKER, WALTER W. LAW, of Mrs. PHŒBE HEARST, Miss CATHERINE WOLFE BRUCE, among others, are gratefully remembered in this connection. The money value of these gifts is over $47,000. Mr. EDWARD CROSSLEY, an English member of Parliament and amateur of astronomy, presented to the University in 1895 a three-foot reflecting telescope. Its performance from the year 1879 onwards has shown that it has no superior in the world at present. It is fitted to supplement the work of the three-foot refractor in an important way. This instrument was established in its place by the gifts of many citizens of California. Its dome and mounting were nearly complete in July, 1896. If it is diligently used, other gifts of like nature will come to the observatory as they are needed—and such gifts will be required if the observatory is to maintain its present standing, unless larger provision is made by the State, or unless a subsidy is received from the general government.

The observatory has published three quarto and five octavo volumes, besides an Atlas of the Moon, and two volumes printed for us by the Smithsonian Institution, and very many separate articles published in scientific journals. Some permanent provision should be made for the publication of its work.

In the years which are to come, I wish for the observatory the fullest measure of brilliant success. Its equipment, situation, and its personnel will command this, if it is adequately supported. I am proud to have been connected with the observatory from its inception, and during its early and formative period, and to have done my part towards the creation and maintenance of the spirit which has characterized its own researches and its relations

to other scientific establishments throughout the world. I have given my best endeavors to these ends for twenty-three years.

I am, gentlemen,

Very respectfully and truly yours,

EDWARD S. HOLDEN."

LIST OF RECORDED EARTHQUAKES ON THE PACIFIC COAST, 1769–1897, BY EDWARD S. HOLDEN; ILLUSTRATED.

The Smithsonian Institution is about to print, in its *Miscellaneous Contributions*, a work with the above title. The data are derived from a similar list of recorded earthquakes, 1769–1888 (with a very considerable number of additions and a few corrections), which was issued by the University of California in 1888, and from the annual publications of the Lick Observatory (printed in the *American Journal of Science*, the *Publications* of the Astronomical Society of the Pacific, the *Bulletins* of the U. S. Geological Survey) since that date. The annual records referred to have been compiled by Messrs. HOLDEN, KEELER, and PERRINE from observations at Mt. Hamilton, and from miscellaneous reports of earthquake shocks. They have been thoroughly sifted and revised in the present work, which is believed to contain all trustworthy data on the subject of Pacific Coast earthquakes since 1769. E. S. H.

MT. HAMILTON, September 1, 1897.

MEASURES OF THE COMPANION OF *SIRIUS*, AND OF β 883.

I have obtained measures of the companion of *Sirius* on two nights, September 23d and October 2d. On the former date the companion was readily seen for at least ten minutes after sunrise. The measures are:—

	θ_c	ρ_c	Weight.
1897.731	$175^\circ.9$	$3''.92$	5
1897.756	174 .4	4 .04	3

Another binary star of considerable interest is β 883. It was discovered by Mr. BURNHAM in 1879, and was soon found to be in rapid motion. Dr. SEE (*Monthly Notices* R. A. S., June, 1897), in a recent investigation, found the period to be only five and a half years. If this result is even approximately correct, the star is by far the most rapid visible binary known.

I have secured three measures recently with the 36-inch

telescope. The two components are of nearly the same magnitude, and the angles may need to be increased by 180°.

	θ_0	ρ_0	Weight.
1897.715	30°.6	0″.23	3
.731	29 .9	0 .26	4
.797	28 .4	0 .28	2

R. G. AITKEN.

October 23, 1897.

THE *LEONIDS* IN 1897.

The *Leonids* were watched for from November 13th to November 18th, inclusive, but no unusual shower was seen. In fact, the displays were very meager, the greatest number being observed on the morning of November 17th, when nine *Leonids* were counted from $3^h\ 40^m$ to $4^h\ 30^m$ A.M. As the Moon was in this region of the heavens and near the time of last quarter, the conditions were not the best. C. D. P.

COMETS DUE TO RETURN IN 1898.

In the year 1898 there are no less than five periodic comets due to return to perihelion:—

Winnecke, March 20th; Encke, May 26th; Swift, 1889 VI; Wolf, June 30th; Temple's first periodic comet.

Of these comets, Winnecke's, Encke's, and Wolf's are well determined and should be found, except, perhaps, Wolf's which is so situated that it does not become very bright — only about two and a half times as bright as at the time of its rediscovery in 1891, when Professor BARNARD estimated it at thirteen and a half magnitude.

In the case of Swift's comet, there is an uncertainty of 0.9 year in the time of perihelion passage, which precludes any accurate prediction of its place, and hence renders impracticable any extended search with large telescopes. Those having small and moderate-sized telescopes will do well to devote some of their time to sweeping, with the chance of picking up this comet, and thereby save another from being added to the already long list of missing ones.

Temple's first periodic comet was observed at the returns of 1873 and 1879, subsequent to its discovery in 1867, but at the last two apparitions it was not seen. It is to be hoped that it may be rediscovered at the coming apparition.

The Temple-Swift comet (1869 III, 1880 IV, 1891 V) was due to pass perihelion on June 4th of the present year, but owing to the unfavorable situation of the Earth, the comet was always in the twilight, and being on the opposite side of the Sun from the Earth, its brightness was small, and hence was not found. Its next return should be more favorable. C. D. P.

MT. HAMILTON, November 20, 1897.

PHOTOGRAPH OF THE SPECTRUM OF A METEOR.

In Harvard College Observatory *Circular* No. 20, dated November 8, 1897, Professor E. C. PICKERING states that the spectrum of a meteor has been photographed for the first time.

At about 11 P.M. on June 18, 1897, when the eight-inch BACHE telescope (provided with a large objective prism) at Arequipa, Peru, was directed towards the constellation *Telescopium*, a bright meteor appeared in Right Ascension $18^h\ 19^m$, Declination $-47^\circ\ 10'$, and passed out of the field of view at Right Ascension $18^h\ 29^m$, Declination $-50^\circ\ 30'$.

Mrs. FLEMING'S examination of the photographic plate shows that the spectrum consists of six bright lines, whose intensity varies in different positions of the photograph, thereby showing that the light of the meteor changed as its image passed across the plate. The intensities of these lines are estimated at 40, 100, 2, 13, 10, and 10, respectively, and their wave lengths show that the first, second, fourth, and sixth lines are probably identical with the hydrogen lines H_ϵ, H_δ, H_γ, and H_β. The fifth line is probably identical with the band which forms the distinctive feature of the spectra of stars of the third class of the fifth type, and the third line, which is barely visible, is perhaps identical with another band contained in these stars.

The H_δ line is the most intense of the four hydrogen lines in the spectrum of the meteor. This is also the case in the spectrum of *o Ceti*, and of many other variable stars of long period. The relations between the other hydrogen lines also indicate an important resemblance between meteors and stars having bright lines in their spectra. These results may aid in determining the conditions of temperature and pressure in these bodies.

Professor PICKERING adds that special efforts will be made to photograph meteor trails and spectra during the November meteoric shower of this year. R. G. AITKEN.

DIMENSIONS OF THE PLANETS AND SATELLITES.

In *Popular Astronomy* for October, 1897, Professor E. E. BARNARD gives the results of "A Micrometrical Determination of the Dimensions of the Planets and Satellites of the Solar System, Made with the 36-inch Refractor of the Lick Observatory."

Below are given Professor BARNARD'S results in English miles, and for comparison the values given in YOUNG'S *General Astronomy* (second issue, 1889).

		BARNARD.	YOUNG'S GENERAL ASTRONOMY.
		Miles.	Miles.
*Mercury**		2,765	3,030
Venus		7,826	7,700
Mars	Eq.	4,352	4,230 (mean diam.)
	Pol.	4,312	
Ceres		485	No previous micrometric measures.
Pallas		304	
Juno		118	
Vesta		243	
Jupiter	Eq.	90,190	88,200
	Pol.	84,570	83,000
Jupiter's Satellites	I	2,452	2,400+
	II	2,045	2,100+
	III	3,558	3,600
	IV	3,345	3,000
Saturn	Eq.	76,470	75,000±
	Pol.	69,780	68,000±
Saturn's Rings	Outer diameter, outer ring	172,610	168,000
	Inner " " "	150,480	148,000
	Center Cassini Division	148,260	. . .
	Outer diameter, inner ring	145,990	144,800
	Inner " " "	110,070	111,800
	" " crape ring	88,190	91,800±
	Width Cassini Division	2,220	1 600±
	Diameter satellite *Titan*	2,720	3,000 or 4,000 (Probably.)
Uranus, mean diameter		34,900	31,900
Neptune, " "		32,900	34,800

R. G. AITKEN.

CHANGES IN THE U. S. COAST AND GEODETIC SURVEY.

Mr. HENRY S. PRITCHETT, Ph. D. (Munich), professor of physics and astronomy in Washington University, St. Louis, has been appointed by the President, Superintendent of the United States Coast and Geodetic Survey in the place of General

* Professor BARNARD states that his measures of *Mercury* were made with the 12-inch telescope at the transits of 1891 and 1894.

W. W. DUFFIELD, resigned. Professor PRITCHETT was Assistant Astronomer at the Naval Observatory, Washington, from 1878 to 1880. He has engaged in work for the survey in China and Japan, as well as in the United States.

THE TELEGRAPHIC LONGITUDE NET OF THE UNITED STATES.

In the *Astronomical Journal*, No. 412, Professor CHARLES A. SCHOTT, of the United States Coast and Geodetic Survey, publishes a brief summary of the longitude work done by the Survey between 1866 and 1896. From this paper, the following extracts are taken:—

In 1851, S. C. WALKER, Assistant, reported the following values for the longitude of the Cambridge Observatory:—

	West of Greenwich.		
	h	m	s
From Moon culminations,	4	44	28.42
From eclipses, transits, and occultations,	4	44	29.64
By chronometric expeditions,	4	44	30.10

In the autumn of 1845, Superintendent BACHE instructed Assistant WALKER to devise practical means for the employment of the electric telegraph (publicly tested by MORSE in May, 1844) for longitude work. With the co-operation of the United States Naval Observatory, the cities of Washington and Philadelphia were connected on October 10, 1846, and their difference of longitude was found to be $7^m\ 34^s.3$. After Professor WALKER'S retirement in 1852, Dr. B. A. GOULD took charge of the longitude work of the Survey up to 1867; the Coast Survey Report of that year contains his report "On the Longitude between America and Europe from Signals through the Atlantic Cable." The resulting longitude of the Cambridge Observatory was $4^h\ 44^m\ 30^s.85$.

Other cable determinations were secured by the Coast Survey in 1870 and 1872, but the latest determination, in 1892, is due to the co-operation of the McGill College Observatory at Montreal, Canada, with the Greenwich Observatory.

The final value for the longitude of the Harvard Observatory at Cambridge, as adjusted in June, 1897, is, —

$$4^h\ 44^m\ 31^s.046\ \pm 0^s.048.$$

The longitude net as developed during thirty years, including some European stations, is composed of forty-five stations, connected by seventy-two links. Practically, three lines cross the continent, one near our nothern boundary, one near the southern,

and an intermediate one and the three are connected by cross lines. The smallness of the probable errors of measure shows the satisfactory character of the observations.

The table of final resulting longitudes west of Greenwich is as follows:—

	h	m	s	
Greenwich, England (Transit circle)	0	0	0.000	
Paris, France (Meridian of France)	0	9	20.968	E.
Brest, France (Tower of St. Louis)	0	17	57.597	
Foilhommerum, Ireland (Transit)	0	41	33.409	
Heart's Content, Newfoundland (Transit)	3	33	29.788	
St. Pierre Island, Miquelon Group (Transit)	3	44	42.427	
Calais, Maine (Transit)	4	29	7.857	
Duxbury, Mass. (Transit)	4	42	40.858	
Cambridge, Mass. (Dome, Harvard College Obs'y)	4	44	31.046	
Montreal, Canada (Transit McGill College Obs'y)	4	54	18.634	
Albany, N. Y. (Dome, Dudley Obs'y; old site)	4	34	59.992	
Cape May, N. J. (Transit)	4	59	43.045	
Washington, D. C. (Dome U. S. N. Obs'y; old site)	5	8	12.153	
Charleston, S. C. (Transit)	5	19	44.076	
Key West, Fla. (Transit)	5	27	13.579	
Detroit, Mich. (Transit of 1891)	5	32	11.830	
Atlanta, Ga. (Transit of 1896)	5	37	33.338	
Cincinnati, O. (Dome, Mt. Lookout Obs'y)	5	37	41.398	
Louisville, Ky. (Transit)	5	43	3.636	
Nashville, Tenn. (Transit)	5	47	8.083	
Chicago, Ill. (Transit of 1891)	5	50	29.446	
New Orleans, La. (Transit of 1895)	6	0	16.763	
St. Louis, Mo. (Transit, 1882, of Washington Univ.)	6	0	49.256	
Little Rock, Ark. (Transit)	6	9	5.727	
Minneapolis, Minn. (Transit)	6	12	56.845	
Kansas City, Mo. (Transit)	6	18	21.404	
Galveston Tex. (Transit of 1895)	6	19	9.928	
Omaha, Neb. (Transit)	6	23	46.087	
Austin, Tex. (Transit)	6	30	57.024	
Bismarck, N. D. (Transit)	6	43	7.938	
Colorado Springs, Colo. (Transit of 1886)	6	59	16.710	
Santa Fe, N. M. (Transit)	7	3	46.805	
El Paso, Tex. (Transit)	7	5	57.386	
Nogales, Ariz. (Transit)	7	23	45.912	
Salt Lake City, Utah (Transit)	7	27	35.173	
Helena, Mont. (Transit)	7	28	8.789	
Needles, Cal. (Transit)	7	38	24.836	
Yuma, Ariz. (Transit)	7	38	29.608	
San Diego, Cal. (Transit of 1892)	7	48	38.748	
Los Angeles, Cal. (Transit of 1892)	7	53	1.561	
Walla Walla, Wash. (Transit)	7	53	23.331	
Sacramento, Cal. (Transit)	8	5	58.387	
Seattle, Wash. (Transit)	8	9	20.358	
San Francisco, Cal. (Transit, Lafayette Park)	8	9	42.861	
Portland, Oregon (Transit)	8	10	42.838	

The paper also contains the longitudes of a few prominent observatories directly connected with the Coast and Geodetic Survey system. From these we take the longitude of

U. S. Naval Observatory—*new* site; meridian of clock room:—

$5^h\ 8^m\ 15^s.784 \pm 0^s.050$

Lick Observatory, Mt. Hamilton—meridian of transit house:—

$8^h\ 6^m\ 34^s.895 \pm 0^s.057$

OBSERVATIONS OF THE COMPANION TO *PROCYON*.

The following observations of *Procyon's* companion were made with our great refractor. For the purpose of showing the orbital motion, the discovery position is also given:—

Date. 1897.	Position Angle.	Distance.
October 8.	324°.1	4″.70
17.	323 .0	——
18.	323 .8	4 .76
29.	324 .2	4 .51
30.	326 .2	4 .59
November 1.	324 .3	4 .67
15.	325 .2	4 .71
Mean position for 1897.821	324 .40	4 .66
Discovery position 1896.812	318 .8	4 .59

Procyon's companion has finally been seen at two other observatories. Dr. SEE of the Lowell Observatory informs me that he and his assistant, Mr. BOOTHROYD, saw and measured the companion on the 1st of the present month. Professor BARNARD writes that on the 3d, during a few moments of steadiness, the companion was "clearly and distinctly seen" with the great refractor of the YERKES Observatory. So far as I know, these are the only observations made away from Mt. Hamilton. J. M. S.

LICK OBSERVATORY, November 18, 1897.

LICK OBSERVATORY ECLIPSE EXPEDITION.

The CROCKER eclipse expedition from the Lick Observatory, to observe the total solar eclipse of January 21–22, 1898, sailed from San Francisco on the steamship "China" on October 21st, going via Hongkong to Bombay. From this point it is expected to move inland some 150 or 200 miles, to a station near Karad. The expedition is in charge of Professor W. W. CAMPBELL.

He is accompanied by Mrs. CAMPBELL and Miss ROWENA BEANS as volunteer assistants, traveling at private expense.

Professor CAMPBELL takes with him a number of instruments for the observation of the eclipse, and expects to secure the needed assistance in India. Besides the 40-foot telescope for large-scale photographs of the corona on Professor SCHAEBERLE'S plan, he has several spectroscopes for special observations. An effort will be made to photograph the changes in the spectrum due to the "reversing layer," which have been noticed visually at previous eclipses, and also to secure photographs of the 1474 K line, for the purpose of determining the question of rotation of the corona.

The funds to defray the expenses of the expedition were provided by the late Colonel C. F. CROCKER, who had provided for two previous eclipse parties from the Lick Observatory.

A private cablegram from the party at Hongkong advises their safe arrival at that port and their close connection with the steamer for Bombay. The latter port should be reached about December 5th. C. D. P.

THE CHABOT OBSERVATORY ECLIPSE EXPEDITION.

Professor CHARLES BURCKHALTER, Director of the Chabot Observatory, Oakland, Cal., sailed for Hongkong on Saturday, October 30th, and will proceed to India for the purpose of observing photographically the total solar eclipse of January 22, 1898. The exact location of his station will not be decided until he reaches Bombay. Probably it will be somewhere near one of the railroads, a short distance from that city.

Professor BURCKHALTER'S apparatus is essentially the same as that he took to Japan in 1896, an account of which may be found on page 157, Vol. VII, of these *Publications*.

The equipment described therein has been augmented by another lens of the same diameter and focal length, which is the gift of Dr. GEORGE C. PARDEE. It will be packed separately from the other, so that in the event of the loss, damage, or delay of any of the baggage, he will be reasonably sure of having one lens. It is his intention to use both lenses, one with his shutter, the other in the usual manner. The two tubes will be mounted together, one above the other, and the exposures will be coincident, both as to duration and period.

A new mounting was necessary, on account of the additional

load. It is constructed almost entirely of heavy gaspipe, and is extremely rigid. The polar axis is hollow, and is fitted with an eyepiece, as an aid in adjusting. The automatic arrangements for securing certainty in exposing have been elaborated upon to such an extent that the inventor now feels certain that nothing can go wrong, at least with this part of the expedition.

Professor BURCKHALTER'S parting injunction to his friends was not to wish him a good time or a pleasant journey, but that he might have two minutes of clear sky at the right time. Those of us who have heard him describe the disappointing day in Japan in 1896, and who realize what the success of this expedition means, will be certain to remember him on the eventful day. If friendly good wishes can insure success, he will have it.

ALLEN H. BABCOCK.

ELEMENTS OF COMET *b*, 1897 (PERRINE).

From Mt. Hamilton observations, made on October 16th, 18th, and 20th, we have computed the following elements of the orbit of this comet:—

$$T = 1897 \text{ Dec. } 9.89171 \text{ G. M. T.}$$

$$\left.\begin{aligned} \omega &= 67^\circ\ 6'\ 55''.2 \\ \Omega &= 32\ \ 8\ \ 37\ .4 \\ i &= 69\ 45\ 43\ .2 \end{aligned}\right\} \text{Mean equinox and ecliptic of 1897.0}$$

$$\log q = 0.129500.$$

Residuals for the middle place (O — C):—

$$\Delta\lambda \cos\beta = +\ 2''.8,\ \Delta\beta = +2''.4.$$

A comparison of observations made on November 1st with the ephemeris positions computed from these elements shows a satisfactory agreement. W. J. HUSSEY and R. G. AITKEN.

November 3, 1897.

ASTRONOMICAL TELEGRAMS *(Translations)*.

Lick Observatory, Oct. 17, 1897.

To Harvard College Observatory:
To Students' Observatory, Berkeley: (Sent 1:00 A. M.)

A comet was discovered by C. D. PERRINE, October 16.7398, G. M. T.; R. A. $3^h\ 36^m\ 7^s.6$; N. P. D. $23^\circ\ 13'\ 16''$. The comet is about 2′ in diameter, is as bright as an eighth magnitude star, has a well-defined nucleus and a tail less than 30′ long.

Lick Observatory, Oct. 18, 1897.

To Harvard College Observatory:
To Students' Observatory, Berkeley: (Sent 1:40 P.M.)

Comet *b*, 1897 (PERRINE), was observed by C. D. PERRINE, October 17.7121, G. M. T.; R. A. $3^h\ 30^m\ 25^s.7$; N. P. D. $21^\circ\ 42'\ 47''$.

Lick Observatory, Oct. 18, 1897.

To Harvard College Observatory:
To Students' Observatory, Berkeley: (Sent 9:55 P.M.)

Comet *b*, 1897 (PERRINE), was observed by W. J. HUSSEY, October 18.6498, G. M. T.; R. A. $3^h\ 24^m\ 2^s.2$; N. P. D. $20^\circ\ 16'\ 06''$.

Lick Observatory, Oct. 19, 1897.

To Harvard College Observatory: (Sent 5:10 P.M.)

Comet *b*, 1897, was observed with the Meridian Circle by R. H. TUCKER, October 18.9011, G. M. T.; R. A. $3^h\ 22^m\ 5^s.5$; N. P. D. $19^\circ\ 52'\ 49''$.

Lick Observatory, Oct. 19, 1897.

To Harvard College Observatory: (Sent 9:15 A.M.)

Elements and ephemeris of Comet *b*, 1897, were computed by W. J. HUSSEY and R. G. AITKEN.

ELEMENTS.

$T =$ G. M. T. 1897, Dec. 9.2300.

$$\left.\begin{aligned} \omega &= 66^\circ\ 28' \\ \Omega &= 32\quad 5 \\ i &= 69\quad 38 \end{aligned}\right\}\text{Mean equinox of 1897.0}$$

$q = 1.3525.$

[The ephemeris at four-day intervals, from October 20th to November 1, 1897, is here omitted.]

Minutes of the Meeting of the Board of Directors, held in the Rooms of the Society, November 27, 1897.

Mr. Pierson presided. A quorum was present. The minutes of the last meeting were approved. The following members were duly elected:—

List of Members Elected November 27, 1897.

Prof. Albert S. Bickmore	American Museum of Natural History, Central Park, New York, N. Y.
Miss Gearon	St. Margarets', Barrowgate Road, Chiswick, England.
Mr. A. Perrenod	Saint-Pierre, Martinique.

The following letter was presented to the Directors:—

Mount Hamilton, October 1, 1897.

The Board of Directors, Astronomical Society of the Pacific.

Gentlemen:—I beg to tender my resignation as a member of the Directors A. S. P., and as one of the Committee on Publication, to take effect on December 1, 1897. I shall hope to retain my connection with the Society during my lifetime. I have the pleasure of thinking that the situation of our Society is much improved since the early days of its formation, and that our power and influence for good is now well established, thanks to the unwearied efforts of some of the members. In spite of some obstacles which have had to be overcome, it would seem that we are now firmly established as a veritable force for advancing Science in the United States and elsewhere.

I wish for the Society continued success and usefulness, and it will be my effort, in the future as well as in the past, to contribute to these ends to the best of my ability.

With my personal good wishes to each one of your Board, and my thanks for your friendship during the years of our pleasant association, believe me, Gentlemen,

Very cordially yours,

Edward S. Holden.

Upon motion by Mr. Pierson, the following resolutions were adopted:—

Whereas, Dr. Edward S. Holden has tendered his resignation as a member of the Board of Directors of this Society, and the Board is now called upon to act on the same, be it

Resolved, That it is with sincere regret that the Board accepts said resignation, which it does solely for the reason that Dr. Holden's absence from the State prevents him from attending to the duties of the office;

Resolved, That as the founder of this Society, as its First President, as a continuing member of its Board of Directors, and as the able editor of the *Publications* of the Society, Dr. Holden is entitled to the gratitude of all its members, and deserving of such marks of esteem as this Board has the power to grant; and it is therefore further

Resolved, That Dr. Holden be, and he is hereby elected a Life Member of this Society;—and the Secretary is instructed to forward a copy of these resolutions to him.

The following members were appointed to fill the vacancies caused by Dr. Holden's resignation; to date from December 1, 1897:—

As First Vice-President	Mr. E. J. Molera.
As a Director	Mr. R. H. Tucker.
As a member of the Committee on Publication.	Mr. F. H. Seares.

Adjourned.

MINUTES OF THE MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, HELD IN THE LECTURE HALL OF THE CALIFORNIA ACADEMY OF SCIENCES, NOVEMBER 27, 1897.

The meeting was called to order by Mr. WILLIAM S. MOSES. The minutes of the last meeting, as printed in the *Publications*, were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The following papers were presented:—

1. Dedication of the Yerkes Observatory, by Mr. FREDERICK H. SEARES.
2. Planetary Phenomena for January and February, 1898, by Professor M. MCNEILL, of Lake Forest.
3. Catalogues III and IV of New Nebulæ discovered at the Lowe Observatory, by Dr. LEWIS SWIFT.
4. The Yerkes Observatory, by Professor W. J. HUSSEY.
5. Comet *b*, 1897, by Mr. C. D. PERRINE.

Mr. SEARES delivered an address upon the dedication of the Yerkes Observatory, giving a description of the equipment of this institution, and an account of the opening exercises, which he attended in person.

Adjourned.

OFFICERS OF THE SOCIETY.

Mr. WILLIAM ALVORD	*President*
Mr. E. J. MOLERA	*First Vice-President*
Mr. FREDERICK H. SEARES	*Second Vice-President*
Mr. CHAUNCEY M. ST. JOHN	*Third Vice-President*
Mr. C. D. PERRINE, Mr. F. R. ZIEL	*Secretaries*
Mr. F. R. ZIEL	*Treasurer*

Board of Directors—Messrs. ALVORD, MOLERA, MORSE, Miss O'HALLORAN, Messrs. PERRINE, PIERSON, SEARES, ST. JOHN, TUCKER, VON GELDERN, ZIEL.

Finance Committee—Messrs. WILLIAM M. PIERSON, E. J. MOLERA, and C. M. ST. JOHN.

Committee on Publication—Messrs. AITKEN, BABCOCK, SEARES.

Library Committee—Messrs. HUSSEY and SEARES and Miss O'HALLORAN.

Committee on the Comet-Medal—Messrs. HOLDEN (*ex-officio*), SCHAEBERLE, CAMPBELL.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. RUTHVEN W. PIKE.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—M. FRANCISCO RODRIGUEZ REY.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars per volume to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

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GENERAL INDEX TO VOL. IX.